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STEAM GENERATION
POWER GENERATION
WATER POWER
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AIR CONDITIONING & HEATING
REFRIGERATION
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JANUARY, 1941

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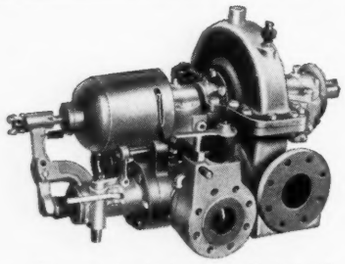

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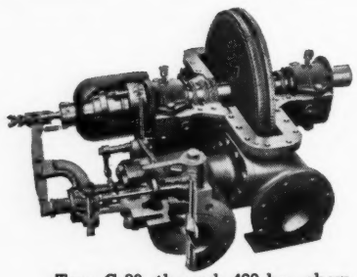

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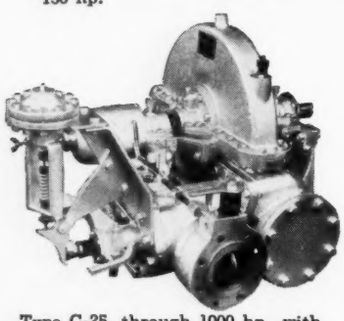

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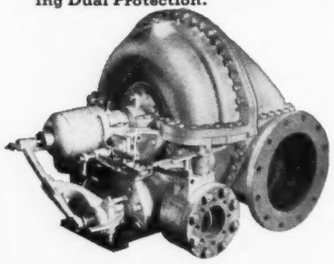

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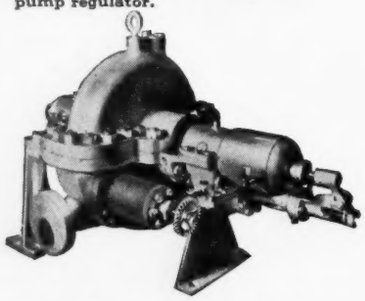

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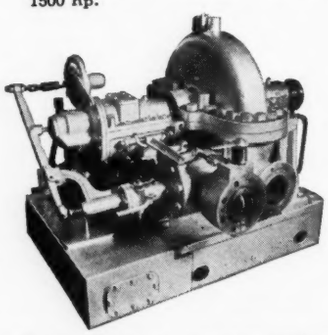

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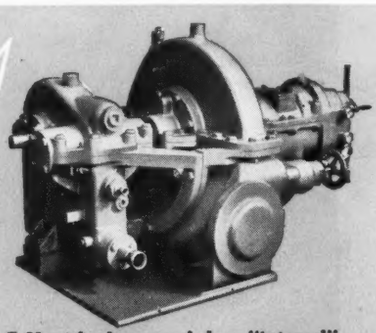
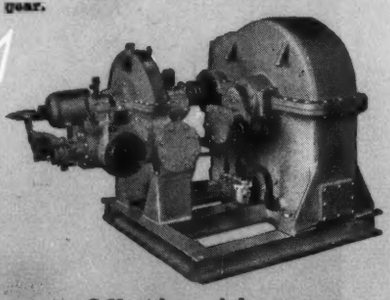
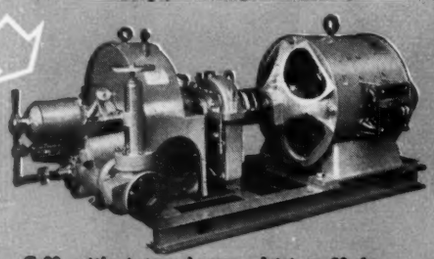


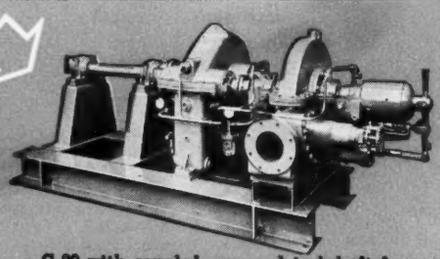
C-20 with close-coupled or "integral" gear.



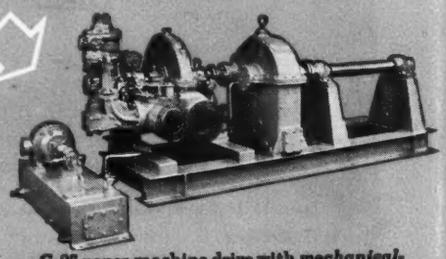
C-20 with coupled gear.



C-20 with integral gear driving 60 kw alternator.



C-20 with coupled gear and jackshaft for pulley mounting in belt drive.



C-25 paper machine drive with *mechanical-oil relay governor,* speed range 25 to 1.

Westinghouse

POWER

Established 1882 • PHILIP W. SWAIN, Editor

The Most Important Months

This is the New Year, in some respects unlike any mankind has known. Viewed superficially, it will bring to America certain good things for which we all have longed and worked. Unemployment will be cut by millions. Business will be very good. The national income will rise notably. "Prosperity" will be in the air.

All this—and the sense of mutual participation in a gigantic defense program—will bring a certain electric thrill to the American people. These will be exciting days.

Even the newspaper accounts of great nations engaged in a death struggle—stories of might and valor, of attacks, retreats, great victories and stubborn resistance—may be watched from a distance with pleasurable excitement like that of the ancient Roman viewing the gladiatorial combat from the safe bleachers of the Coliseum.

But those who think soberly will temper their enthusiasm for "good business" and a "good fight", remembering that the fights of 1941 will be fought in tears and blood and its "prosperity" paid for like that of a man who buys himself a costly Christmas present out of his own pocket. They will also see that all this defense activity is for one purpose only—to preserve our America.

Our peril may not be immediate, but England's is, and her fall would be our deadly and immediate peril. Our one national job right now is to produce fast enough to prevent the former, if possible, and to be ready ourselves in time if need be.

The true measure of the patriotism of every man in industry today is the effort he makes to increase production of the defense essentials. This effort must extend right through 1941, and probably through 1942 as well, but January, February and March of this year will be the most important months for the good it will do in the crucial days of next Spring.

To the power engineer, known to all as a key man of industry, we bring this New Year's greeting: "In 1941 may you keep up steam and voltage, may you have your machines always on the line when needed, may the dependability of your services and equipment be taken for granted—by all except yourself."

Tech.

New Plant Saves $3000 per Month for

Operation of single boiler, fired by Stowe stoker, and unusual mixed-pressure extraction turbine driving ac and dc generators, show reduction in power costs that will payout investment in 4 years. R R Jones, consulting engineer, Akron, tells how and why equipment was selected

▶ The Republic Rubber Co, Youngstown, Ohio, a wholly owned subsidiary of Lee Rubber and Tire Corp, manufactures mechanical rubber goods. It has always generated its own power, since the days 30 years ago when, under the founding management, it was a leading producer of passenger and truck tires.

The original installation comprised Buckeye engines driving Bullock generators supplying the 240-volt dc system. Several of these engines are still in the plant and were in use until the new plant was completed, although installed as long ago as 1905. Two low-pressure turbines served by jet condensers, the last installed in 1913, completed the generating equipment. The original Heine boilers long since disappeared, being replaced during 1910–12 by Rust boilers fired by Roney stokers and Connolly boilers fired by underfeeds. Steam generated at 150 lb saturated supplied the factory, the generating units, pumps and auxiliaries.

Plant cold-water supply, needed for rubber mixing, comes from an abandoned coal mine nearby, which is permitted to fill with cold water during the winter and is emptied in the summer. This also serves as a source of boiler makeup. Use without treatment contributed to the relatively short life of the old boilers.

A Study of the Plant

In 1935, a study of the plant resulted in formulation of a long-range plan to replace outmoded and worn equipment and to bring power costs, a major item in rubber manufacture, into line. The report recommended immediate replacement of the forced-draft cooling tower and subsequent installation of a softening plant, a medium-pressure boiler, and a mixed-pressure extraction turbine-generator and condenser, designed to supply both ac and dc.

All this work has now been completed. Installation of the boiler and softening plant was authorized in 1937 and completed in 1938.

Before writing specifications for a boiler to be installed in an existing plant the engineer must consider a number of important points: (1) the plant should be simple, free from gadgets that may get out of adjustment and take the single boiler out of service, (2) the pressure chosen should afford the best average heat balance for the entire project, (3) the pressure should be related to the amount and quality of makeup, (4) the existing staff must be able to take over operation of new equipment without unwanted outside help, (5) the boiler must fit space available and other physical limitations, and (6) the cost and kind of fuel available and the yearly load factor must be matched to give highest "dollar efficiency."

Selecting the Pressure

The preliminary studies showed that a fair steam and power balance would exist under predicted conditions with a steam pressure of 450 lb and a total temperature of 650 F. At this conservative pressure, no trouble was anticipated from the 50 to 75% makeup required. Since the boiler was to be installed first, it would have to be operated at factory line pressure, 150 lb, and at an output as near as possible to the total use of steam, 90,000 lb per hr.

The ability of men grown old in the operation of boiler plants 25 or more years old often lies at the bottom of the success or failure of new single-boiler plants for medium or high pressures. In this case, there was little doubt that the existing staff could handle the new unit, particularly if fired by automatic control.

Preliminary studies showed a distinct advantage for local strip-mine coals, notably Ohio No. 5 seam, which proved considerably cheaper than coals usually shipped into the Youngstown area. These local coals run high in moisture, low in fusion temperature. They are more or less free-burning, and cost about $2.00 per ton at the plant ($2.82 since Guffey Act). Low fuel cost and usual industrial-plant load factor meant that only a minimum of heat recovery equipment could be justified economically, in this case, a small economizer.

These factors, and the limited space available, resulted in specifying a boiler rated at 65,000 lb per hr continuous

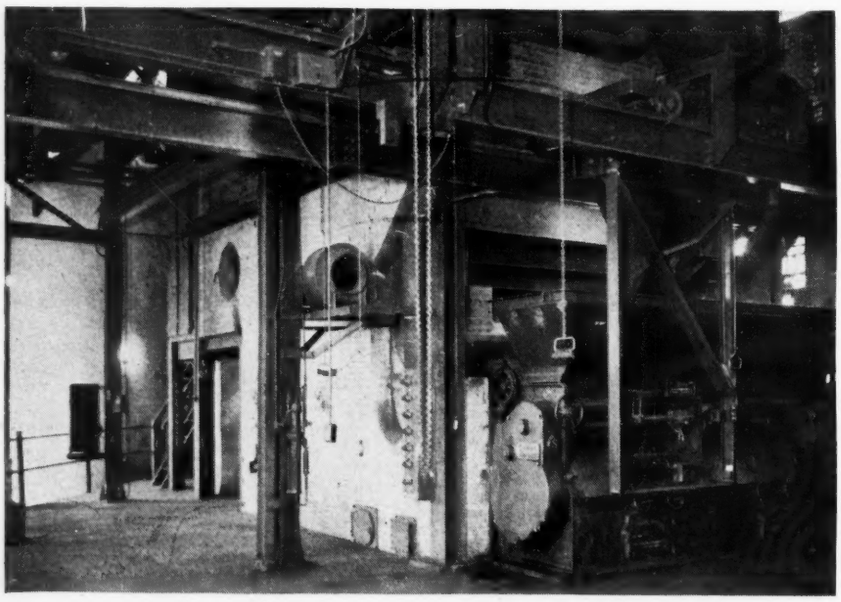


Fig. 1—New boiler and auxiliaries fit limited space available

R v.85 pt.1 Jan.-June 1941

Republic Rubber Company

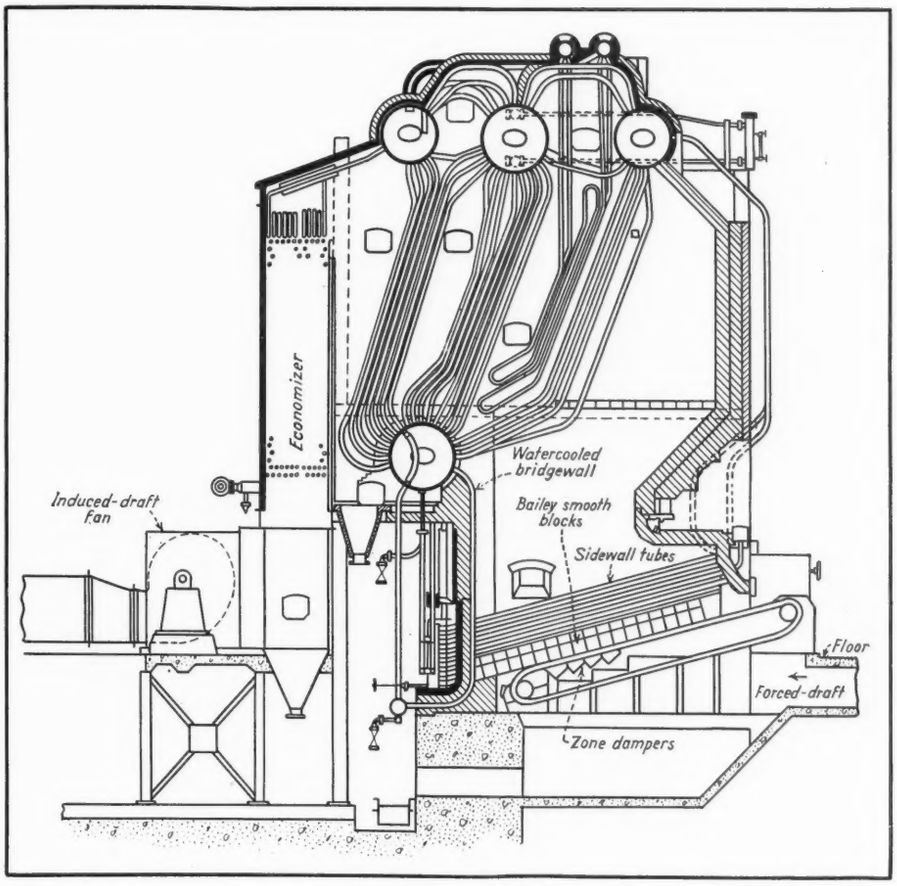


Fig. 2—Cross-section of Stirling boiler fired by Stowe stoker

output, both at 150 lb and 410 F, and 460 lb, 650 F. The unit was to be fitted with a small economizer and a bare brick furnace, except for seven rows of inclined water tubes along the stoker clinker line and a water-cooled bridgewall. This specification also included forced- and induced-draft fans, soot blowers, setting, ducts, and usual small auxiliaries, so the boiler contractor was singly responsible for a complete unit ready for fire.

Available Fuel Considered

Nature of fuel available dictated choice of a Stowe stoker, well suited to handle this relatively low-grade coal. This unit consists of an inclined grate made up of alternate moving and stationary chains; the moving chains carry fresh fuel into the furnace while the retarding action of the stationary sections and the rear cover plates tend to keep the fuel bed under compression, closing up cracks and fissures. The result is a fuel bed of nearly constant thickness. For a more complete description of this stoker see POWER, May, 1939, pg. 283.

The specifications limited furnace heat release at stated rating to 30,000 Btu per cu ft per hr. Efficiency wanted was 85% with about 14% CO_2. All this information, together with dimensions of space available, was sent to the boiler manufacturers. No other limitations were placed on the design that would be acceptable, in the belief that, given all necessary information, the maker can produce a better and cheaper unit than if the specifications gave elaborate design details. Fig. 2 shows the arrangement of the Stirling boiler selected and design statistics will be found in the accompanying equipment table.

A further specification covered automatic control of firing rate, air flow and furnace pressure and necessary boiler instruments. A self-supporting panel carries the pressure-operated stoker and fan controls, pressure indicators and integrators for steam and feed pressure and flow, and curve-drawing meters for feed flow and temperature, steam flow and temperature, stack temperature and per cent CO_2. The latter six records all appear on a single strip chart, making it simple to check results and file records. These instruments permit figuring operating efficiency by the loss method.

Starting Up New Boiler

The boiler and associated units went into operation in the fall of 1938, supplying low-pressure steam with the help of one of the old boilers. The new boiler frequently supplied 80,000 lb per hr of the total 90,000-lb plant load. The only trouble experienced was the loss, after several months operation, of 5 waterwall tubes. Extreme variability in lime content of the raw water, resulting from mixture of mine water, city water and condensate, caused the scale formation in the lost tubes. Corrected water conditions eliminated further trouble.

Considerable time was spent, during the start-up period, in adjusting overfire air supply, stoker zone dampers, and teaching the operators to leave the controls alone.

In the following two years of operation, the owner reported an over-all saving of approximately $30,000 per year in coal and maintenance, with stoker maintenance running less than one cent per ton of coal. There has been no difficulty in maintaining 100% availability for operation six days a week, or in holding monthly average efficiency to about 80%, as expected.

Prime-Mover Plans

With the boiler unit operating successfully, plans proceeded for installing a new prime mover to take over from the old generators, the youngest of which was 27 years old. The owners decided that old dc motors would be retained, adding up to a peak of 1200 kw; additions would be made on ac circuits, with an existing peak of 600 kw. This latter current was being purchased. The new plan called for generating all power, dc and ac, in the plant, with the exception of Sunday loads, which would be purchased.

Supplying both dc and ac loads with a single turbine meant driving two generators, generating ac and installing a motor-generator set for dc, or generating dc and installing an inverter set to handle ac. Complication marked both latter plans and although cost was about the same as for the 2-generator

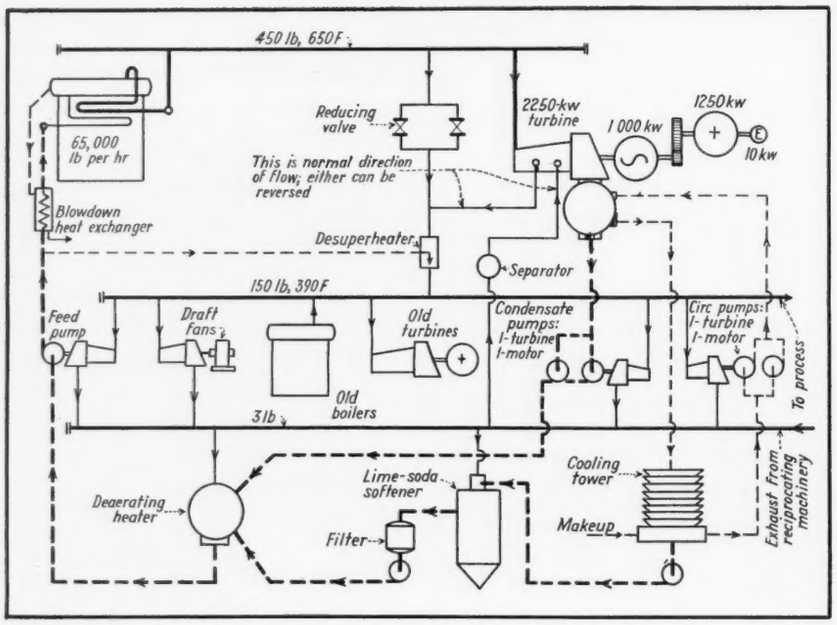


Fig. 3—Flow diagram shows how new equipment combines for an effective heat balance, utilizing available 3-lb exhaust and supplying all steam and power needs

setup, losses would be considerable. Accordingly, the specification called for a single turbine driving two generators. Dusty conditions in the turbine room led to specifying completely enclosed machines, provided with surface air coolers.

The flow diagram (Fig. 3) shows how the turbine fitted into the plant heat balance. The new boiler would supply steam at 450 lb; extraction would meet 150-lb steam requirements in the factory. To take advantage of relatively large quantities of 3-lb steam available from reciprocating machinery in the factory, the unit was to be designed for mixed-pressure operation, taking steam at 3 lb. Furthermore, if an emergency caused outage of the new boiler, the turbine had to be able to run on 150-lb steam, supplied by old boilers serving as standby capacity. According to the power needs, the governor should admit 3-lb steam first, if available, then extract 150-lb steam, and finally use high-pressure steam all the way through.

In addition to this unit, specifications covered a surface condenser to reduce amount of makeup required, a reducing valve and desuperheater, and, to complete the boiler-room modernization, a deaerating heater, feed pumps, phosphate-feeding equipment, and piping. These items are described in the equipment table.

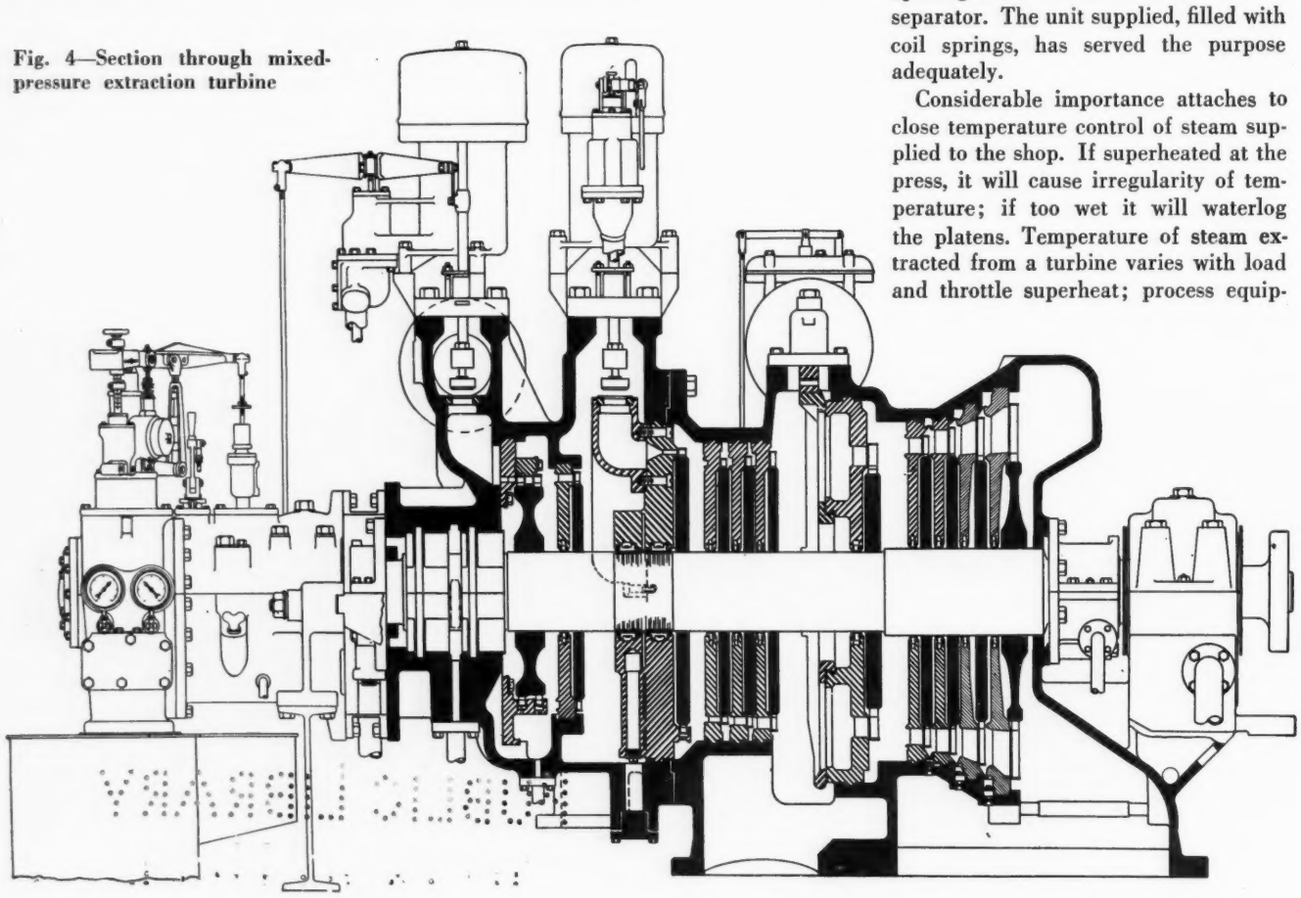
Turbine and Control

The General Electric Co, successful bidders, offered a turbine with two positive-governor-controlled openings to meet the sequence desired (Fig. 4). They elected to drive the ac generator at turbine speed and to gear the dc generator and exciter. Forced ventilation, with fan and filters, removes brush dust on the dc machines. The completely enclosed air-cooled generators are fitted with temperature alarms: a hot-spot indicator on the ac machine and curve-drawing thermometers with alarm on the dc units.

Because 3-lb exhaust comes from reciprocating machinery and carries oil, it was necessary to fit the low-pressure opening of the turbine with an effective separator. The unit supplied, filled with coil springs, has served the purpose adequately.

Considerable importance attaches to close temperature control of steam supplied to the shop. If superheated at the press, it will cause irregularity of temperature; if too wet it will waterlog the platens. Temperature of steam extracted from a turbine varies with load and throttle superheat; process equip-

Fig. 4—Section through mixed-pressure extraction turbine



ment will not tolerate this variation. For this reason, all extracted 150-lb steam, plus any coming through the reducing valves, passes through the desuperheater. This insures holding the constant 390 F found most suitable. To avoid need for another pump, desuperheating water comes from the feed line rather than from the condensate system. So far, no trouble has resulted from solids in the feedwater.

Condenser

Space limitations largely dictated the condenser size, which was finally specified to give a good vacuum with ordinary summer cooling-tower-water temperatures, at a steam load somewhat less than that for straight condensing operation but somewhat more than that expected from extraction operations. Duplicate pumps, one turbine- and one motor-driven, aid in balancing summer and winter conditions.

The more or less standard switchboard provides a double-bus system on the ac side. The turbine does not operate week-ends, when power is purchased. The second bus connects to the outside supply; interlocking oil-circuit breakers and transfer switches prevent possibility of paralleling.

The plant started operation in August, 1940, on 150-lb and 3-lb steam, while the new boiler was out to install additional superheater surface and to make other changes incidental to high-pressure operation. Under these conditions, similar to an emergency outage of the high-pressure boiler, the turbine operated perfectly. With boiler changes complete, high-pressure operation started in September 1940. There has been no trouble with any part of this plant or with the operators handling it. No formal test was made but instrument charts show that a load of 1500 kw is being carried on 9000 lb of 3-lb steam with an extracted flow of 40,000 lb of 150-lb steam, without any flow through the intermediate section of the turbine. Pressure variation of extracted steam stays less than 2 lb and temperature variation runs less than 20 F with both reducing valves and turbine supplying steam to the desuperheater. The boiler produces about 50,000 lb per hr of 450-lb and 650-F steam at an efficiency of approximately 82%.

The owners advise that the saving during the first month's operation, in coal and purchased power, amounted to $2562. This is expected to increase to about $3000 per month as load increases. Maintenance on this new equipment runs extremely low, as might be expected. This monthly saving, plus the saving of $30,000 per year made by the boiler in two years of independent operation, makes a tidy gain for a plant of this size. It will retire the entire investment in about 4 years.

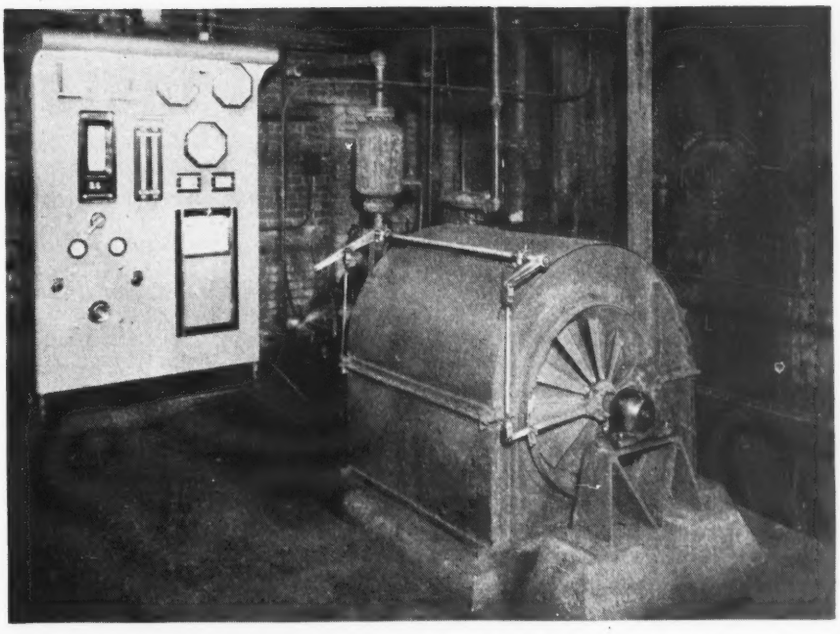


Fig. 5—Boiler control panel and forced-draft fan, opposite boiler

Principal New Power Equipment

Republic Rubber Co, Youngstown, Ohio.

R R Jones, Akron, Consulting Engineer

Steam-Generating Equipment (1938 Project):

Boiler, water-cooled bridgewall, and setting.....Babcock & Wilcox Co
Stirling Class 41, 7150 sq ft effective heating surface; 374 sq ft waterwall surface, all brick setting. Design drum pressure 500 lb per sq in.

Economizer, 2400 sq ft.....Babcock & Wilcox Co

Superheater, to produce 650 F total temperature.....Babcock & Wilcox Co

Stoker, Stowe compensating feed.....Johnston & Jennings Co
171.2 sq ft active grate area; 2-hp oil-gear variable drive

Soot blowers, for 150-lb steam.....Diamond Power Specialty Corp

Forced and induced-draft fans.....Clarage Fan Co

Fan-drive turbines.....Elliott Co

Combustion control and boiler instruments.....Republic Flow Meters Co
Boiler panel mounts Smoot-control master and ratio indicators, dial gages for steam and feed pressure, integrators for feed and steam flow, round-chart recording steam-pressure gage, 6-pen strip-chart recorder for feed temperature and flow, steam temperature and flow, stack temperature and per cent CO_2. Fan throttle operators and CO_2 analyzer separate.

Water-softening plant.....American Water Softener Co
Straight hot lime-soda, capacity 100,000 lb per hr, with two 7½-ft filters, chemical tanks and auxiliaries

Coal-weighing equipment.....Stock Engineering Co
One-ton weigh larry, with ticket printer, motor operated. Works in two directions; one at right angles to stoker hopper.

Boiler Auxiliaries (1940 Project):

Deaerating heater, 70,000 lb per hr.....Elliott Co
300 cu ft storage for deaerated water; on 16-ft legs over feed pumps

Deaerating heater, 70,000 lb per hr.....Elliott Co
One driven by 100-hp 150-lb Elliott turbine; one by 100-hp G E motor

Blowdown heat exchanger, 5000 lb per hr at 460 F.....Struthers-Wells Co
Cooled with 50,000 lb per hr feed at 212 F; 52 sq ft of ⅝-in. tubes

Phosphate feeder.....Seely Instrument, American Steam Pump Co
Seely telechron timer and air-operated valves and American air-operated direct-acting pump taking suction from either of 2500-gal. wood tanks, one with phosphate solution, one with condensate. Pumps phosphate directly to middle drum, then a condensate rinse, idle for rest of cycle.

Turbine-Room Equipment (1940 Project):

Turbine-generator, 3600 rpm, 2500 shaft kw.....General Electric Co
Automatic extraction mixed-pressure condensing turbine driving a 1000-kw ac generator at turbine speed, a 1250-kw, 240-v, 750-rpm geared dc generator, a 15-kw, 750-rpm exciter. Turbine takes throttle steam at 450 lb, 650 F, extracts or admits steam at 150 lb and extracts or admits steam at 3 lb. Generators completely enclosed, fitted with dust filters and surface coolers

Condenser and separate air cooler.....Ingersoll-Rand Co
2570 sq ft combined surface, ¾-in. tubes, to produce 2-in. Hg backpressure with 3180 gpm of 80-F water while condensing 25,000 lb per hr

Circulating and condensate pumps, 2 each.....Ingersoll-Rand Co
One of each pair driven by Elliott turbine, one by Louis Allis motor.

Oil separator, 14-in., for low-pressure opening.....Schutte & Koerting Co

Reducing and desuperheating station.....The Swartwout Co
One 1½-in. and one 3-in. air-operated reducing valves in parallel; single desuperheater takes all 150-lb steam. Capacity, 60,000 lb per hr from 450 lb, 650 F. to 150 lb, 400 F.

Switchgear.....Westinghouse Electric & Mfg Co
Slate-panel ac and dc generator switchboards mounted in line with older ones; three separate feeder cubicles fitted with double-bus system

High-pressure steam piping, welded.....Pittsburgh Piping & Equip Co

How to Select and Install Unit Heaters

Although the tremendous number of possible combinations may make unit-heater selection and installation look complicated, the general principles explained here are actually simple and will enable the engineer to make full use of unit-heater flexibility to solve the many special heating problems encountered in factories, office buildings, stores, warehouses, hangars, etc

▶A PREVIOUS ARTICLE (POWER, Oct, 1940, pg 642), divided unit heaters into three general types: (1) suspended propeller-fan units blowing in a generally horizontal direction, (2) suspended propeller-fan units blowing vertically downward, and (3) floor-, wall- or ceiling-mounted blower-fan units. Each type has features which fit it for particular applications; no one type will meet every situation.

The first step in designing a unit-heater installation involves comparing the general requirements of the installation (total capacity required, direction and length of blow, height of ceilings, conditions of occupancy, permissible noise levels, existence of obstructions or special conditions, etc) with the characteristics of the unit-heater types available.

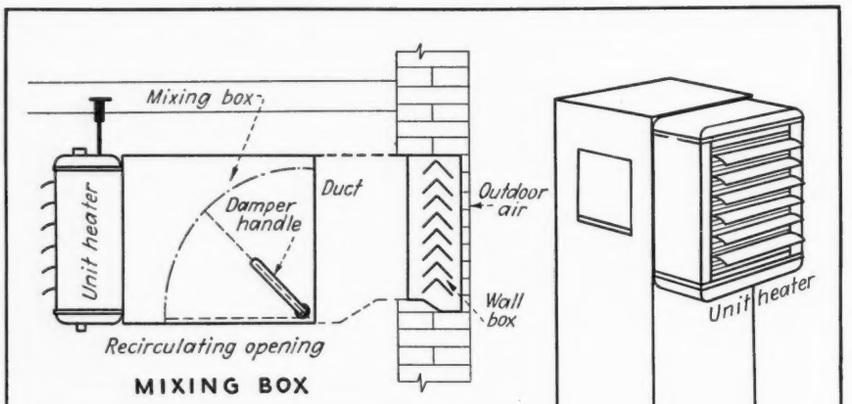
Suspended Propeller-Fan Units

The garden-variety suspended-propeller-fan unit, designed for horizontally downward air flow, meets a wide range of situations simply and economically. These units are available in sizes ranging from 15,000 Btu per hr up to about 500,000 Btu per hr, and with air flows from 300 to 5000 cfm.

Propeller-fan heaters, designed for vertical downward air flow, possess characteristics which fit them for many special applications and which may also fit them to give better performance on the average job. In units of this type, fans are mounted horizontally and outlet velocity is somewhat higher than common in units for horizontal air flow. This means longer "throw" of the air stream. Numerous designs of outlets and louvres for these vertical units permit directing the air stream as a long, narrow vertical cone, as a wide vertical cone, or as a number of air streams moving downward at any selected angle. In addition, one type of heater can be fitted with a revolving discharge which sweeps slowly through 360 degrees, covering successively every direction, causing the air to find its way around obstacles such as machinery or equipment.

Unit heaters of this type suit plants with high ceilings or where obstructions, such as traveling cranes, require installation above the roof trusses. High velocity and long throw insure delivery to the working area where the air stream spreads out, covering an area that can be clearly defined for any given unit and mounting height. These units draw air from the upper levels of the heated space, projecting it downward and thus tend to break up the stratification that often exists where high ceilings permit heated air to gather in layers above working level.

Fitted with Anemostats or other diffusing arrangements, vertical unit heaters can be used in low-ceilinged rooms where the air stream from horizontal heaters might cause disturbing drafts. The symmetrical coverage of the downward air stream makes vertical heaters well suited to small spaces where only a single heater is required, and to blanketing open doorways or other cold spots.



DECIBELS
AVERAGE SOUND CONDITIONS
Existing in Various Rooms and Buildings

40-45 Decibels
Quiet Offices; Auditoriums; Show Rooms; Small Clothing Stores; Home Recreation Rooms; Foyers, etc.

45-55 Decibels
Average Offices; Small Restaurants; Barber Shops; Banking Rooms; Upper Floors of Department Stores; etc.

55-70 Decibels
Gynasiums; Restaurants; Main Floors of Department Stores; Drug Stores; Grocery Stores; Service Stations; Parking Garages; Recreation Halls; Laundries; etc.

70-75 Decibels
Machine Shops; Foundries; Loading Platforms; Packing Plants; Warehouses; Steel Mills; etc.

Fig. 1—Unit heaters fitted with mixing and recirculating boxes; table shows average sound levels, in decibels, found in various rooms and buildings

Blower-fan units, available in sizes up to about one and a quarter million Btu per hr and 20,000 cfm, offer high capacity for heating large spaces with a minimum number of units. The characteristics of the centrifugal fan are such that high velocity is possible which, in turn, produces longer throw. Likewise, the centrifugal fan works well against resistance and so can be used where distributing ductwork is required. Slow-speed centrifugal fans are inherently quiet.

After the general type or types of unit heaters have been selected for a given job it still remains to determine how many shall be used, what sizes are required, and where they shall be placed. The starting point for this design job, as for all other heating-system designs, is the total heat load. This is figured by standard methods, as outlined in the ASHVE Guide and other handbooks. This figure, expressed as Btu per hr, represents the *minimum* unit-heater capacity that must be installed. Other factors to be discussed in the following paragraphs, may act to increase the capacity required but in no case should it be less than the calculated heat load.

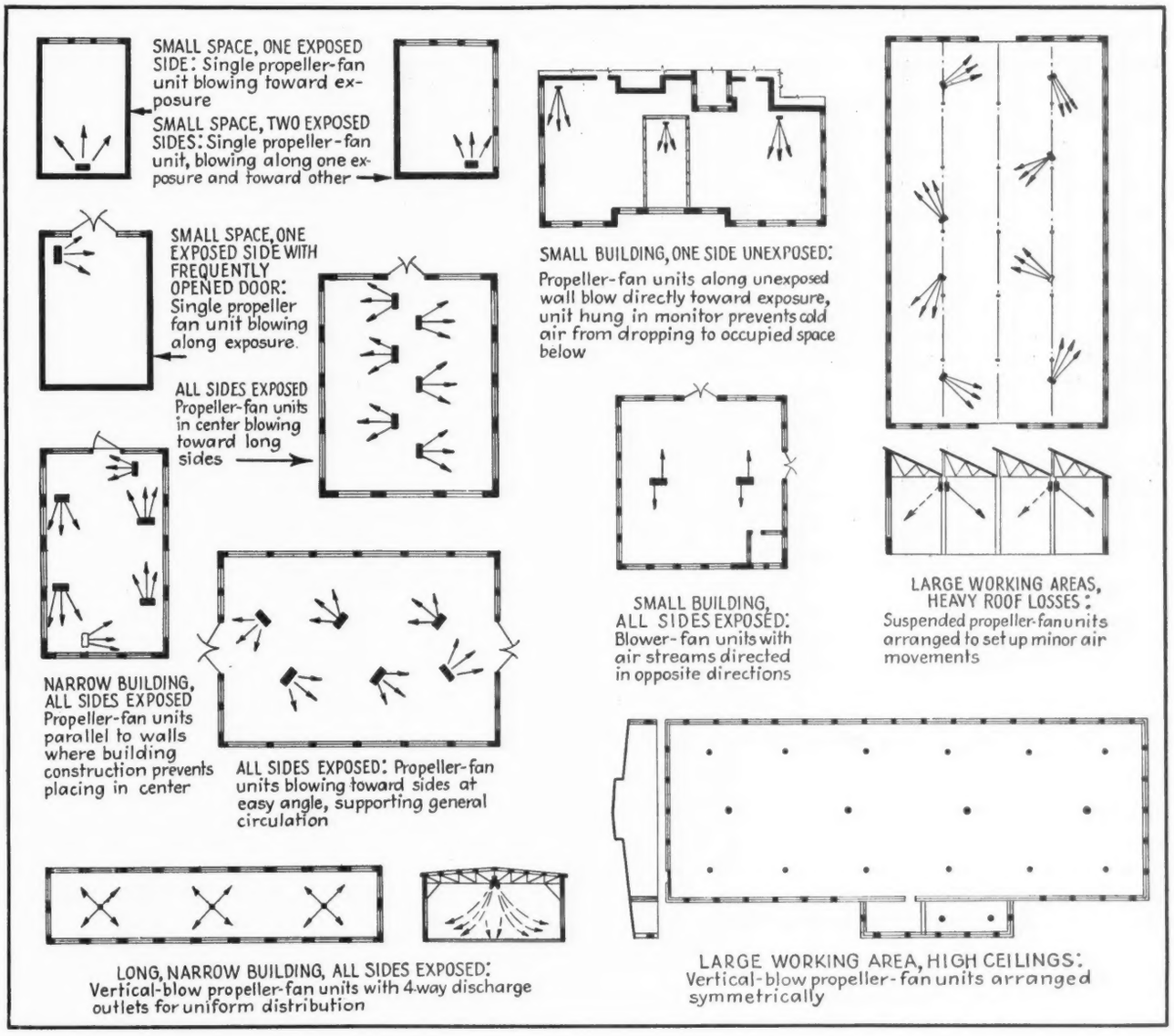
Capacity Tables

Most unit-heater capacity tables are based on 60-F temperature of entering air and 2-lb steam pressure; before converting heat load into required unit-heater capacity, correction must be made for differences in these items. The average suspended unit heater draws air from its own level; this air is considerably warmer than that at the breathing level (5 ft above the floor). For propeller-fan units, temperature at the heater may be approximated by adding, to the temperature maintained at the breathing level, 1.5 F for each foot difference in elevation between breathing line and center of heater intake. For suspended blower-fan units, use approximately 0.75 F per foot.

In the cases where suspended unit heaters take air from close to floor level by means of a recirculating duct (Fig 1), or where a floor-mounted blower-fan unit is involved, the entering air temperature may be taken the same as that to be maintained in the room. For units handling a mixture of recirculated air and outside air (by means of a mixing chamber as shown in Fig. 1), the entering air temperature must be calculated on the basis of the amount of outside air which has been included in the heating-load estimate.

Steam pressure must be that actually available at the heater, not boiler or header pressure. This means allowing for pressure drop in connecting piping, which may be considerable where long lines are involved. Of course, piping

Fig. 2—Suggested arrangements of unit heaters for various building layouts and exposures


SMALL SPACE, ONE EXPOSED SIDE: Single propeller-fan unit blowing toward exposure
SMALL SPACE, TWO EXPOSED SIDES: Single propeller-fan unit, blowing along one exposure and toward other
SMALL SPACE, ONE EXPOSED SIDE WITH FREQUENTLY OPENED DOOR: Single propeller fan unit blowing along exposure.
ALL SIDES EXPOSED Propeller-fan units in center blowing toward long sides
NARROW BUILDING, ALL SIDES EXPOSED Propeller-fan units parallel to walls where building construction prevents placing in center
ALL SIDES EXPOSED: Propeller-fan units blowing toward sides at easy angle, supporting general circulation
LONG, NARROW BUILDING, ALL SIDES EXPOSED: Vertical-blow propeller-fan units with 4-way discharge outlets for uniform distribution
SMALL BUILDING, ONE SIDE UNEXPOSED: Propeller-fan units along unexposed wall blow directly toward exposure, unit hung in monitor prevents cold air from dropping to occupied space below
SMALL BUILDING, ALL SIDES EXPOSED: Blower-fan units with air streams directed in opposite directions
LARGE WORKING AREAS, HEAVY ROOF LOSSES: Suspended propeller-fan units arranged to set up minor air movements
LARGE WORKING AREA, HIGH CEILINGS: Vertical-blow propeller-fan units arranged symmetrically

should be amply sized to keep pressure drop to a minimum.

Rating tables published by manufacturers show in detail how to convert capacity at standard conditions (60 F and 2 lb pressure) into capacity at actual temperature and steam pressure. Comparison of the total Btu per hr required and the corrected capacities of various sizes of units enables the engineer to make tentative choice of number and size of units. Final choice rests on other factors, however.

Circulation of large volumes of air at relatively high velocity and low temperature tends to reduce possibility of stratification and to produce more uniform temperature conditions. For suspended propeller-fan units, volume of air handled should be sufficient to produce at least three air changes in the entire room, per hour. This minimum should be increased to 6 or 7 changes for stores, light manufacturing operations, offices, etc. For floor-mounted propeller fan units drawing air from low levels and discharging at high velocity, the air volume can be reduced somewhat, say, to about 1.5 changes per hr as a minimum. Final air temperature should be held to less than 70-75 F above room temperature.

Mounting Height

In general, all unit heaters except vertical propeller-fan types and high-velocity blower-fan types designed for ceiling mounting should be located as close to the working zone as possible. Manufacturer's rating tables give maximum mounting heights for each unit; some give minimum heights as well. Within this range, height usually depends on headroom required, height of return piping and other practical layout considerations. Unit heaters designed to throw a vertical high-velocity air stream can be located at almost any necessary height.

In many cases, need for quiet operation will determine the size and number of units to be used and the speeds at which the fans are to operate. For industrial buildings, where noise is not of major importance, full-speed capacities may be used. However, for offices, stores, restaurants, etc, where noise is often undesirable, it is good practice to select 2- or 3-speed fans with capacity enough to meet requirements at the lower speeds where operation is quieter. The higher speed can be held in reserve for bringing the space up to temperature after idle periods or for unusually severe conditions. When manufacturers rate their fans for quietness on a definite "decibel" basis, it is possible to select units somewhat more scientifically. Using a table similar to that given in Fig. 1, determine the range of decibels for the conditions to be met and select a fan rated within this range.

In most cases, some one of the foregoing factors will determine the number and size of fans required, at any rate, the minimum number of units can be determined. Whether more units than the minimum will be necessary depends on location requirements and special conditions such as entrances to be blanketed, etc. In general, a large number of smaller units will give better air distribution and consequently somewhat better results, but normally the number of units is held to a practical minimum to reduce installation costs.

By following several simple rules, the average engineer can avoid the common errors in locating unit heaters and can secure adequate distribution without waste of heat. In studying any building for unit-heat installation, look first for exposed surfaces. These must be effectively blanketed with warm air, to prevent cold areas along the exposure. On the other hand, directing excessive air at these surfaces will cause waste of heat. In general, the air stream from the heaters should wipe the exposed surface at a moderate angle. If circumstances require that units blow directly toward exposed surfaces, at right angles, the engineer must make sure that the units have sufficient throw to reach the walls. Heaters should be kept far enough away from exposed surfaces to allow velocity to dissipate; low-velocity air will mix intimately with cold infiltering air, heating the area near the exposed surface with maximum effectiveness. Some manufacturers list minimum and maximum distances.

In factory buildings with large heat losses through the roof, or on the top floor of a multi-story building, some units should be directed away from the wall exposures to create minor air currents which will help combat roof losses.

As far as possible, heaters should be located and directed so that the air stream from one supports that of the next, or, in other words, so that the heaters all help to maintain a general pattern of air movement. Note how this works in the examples of Fig. 3. Avoid directing air streams so that they strike occupants; this consideration may vitally affect the layout in existing plants where work places are fixed. To reduce the amount of piping required, locate heaters as near the boiler as comfort requirements will permit; in multi-story buildings savings result from following the same heater layout on each floor.

First step in locating vertical-blow units involves fixing the mounting height. In many cases where heaters of this type are used, building construction or other factors will fix this immediately and the job becomes one of selecting heaters with sufficient velocity to project an air stream into the working area without excessive dissipation of heat on the way. Where mounting height isn't definitely fixed by structural considerations the manufacturer's recommendation as to height should be followed, after the proper units have been selected.

Vertical-Blow Heaters

Distribution of vertical-blow heaters over a given area is usually symmetrical. In most cases, the area covered by a unit heater of this type is roughly circular, although special discharge openings enable concentrating the air stream where most needed. Heaters are placed so that the edges of the circles touch, or overlap if more heaters are required to handle the total heat loss. Along exposed walls, heaters are placed so that the wall cuts off a quarter or third of the circle, insuring even coverage of the wall surface. Down-blow heaters are particularly effective in meeting cases of severe infiltration such as occur at frequently opened doors, loose-fitting windows, etc. Likewise, the symmetrical distribution of heat makes this type particularly suited for small spaces where one heater can handle the job. The down-blow unit will insure even heating around the perimeter.

The general principles applying to location of propeller-fan suspended units apply to blower-fan units, particularly of the suspended type. Other things being equal, floor-type blower-fan units will produce more uniform results because they withdraw cold air near the floor line, which is constantly replaced with warm air from upper levels. This is also true of suspended units when fitted with recirculating ducts. This withdrawal of cold air from the floor level makes floor units particularly suited for combating cold drafts at doors, etc. Likewise, if units must blow from an exposed wall, the floor type will give best results under these bad conditions. Blower-fan units can be fitted with a wide variety of cowls or hoods to direct the air stream wherever desired; often the effect of several heaters in terms of air circulation can be obtained with no more piping than for one heater.

Breakers Blast Circuits Open

R M Spurck, General Electric engineer, describes the operation of oil-blast, air-blast and magnetic-blast high-voltage circuit breakers with an eye on their applications and duties

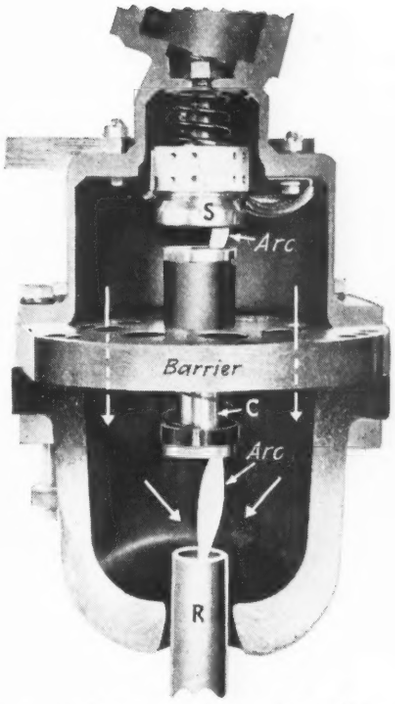


Fig. 1—Operation of a radial oil-blast circuit breaker at time of arc interruption

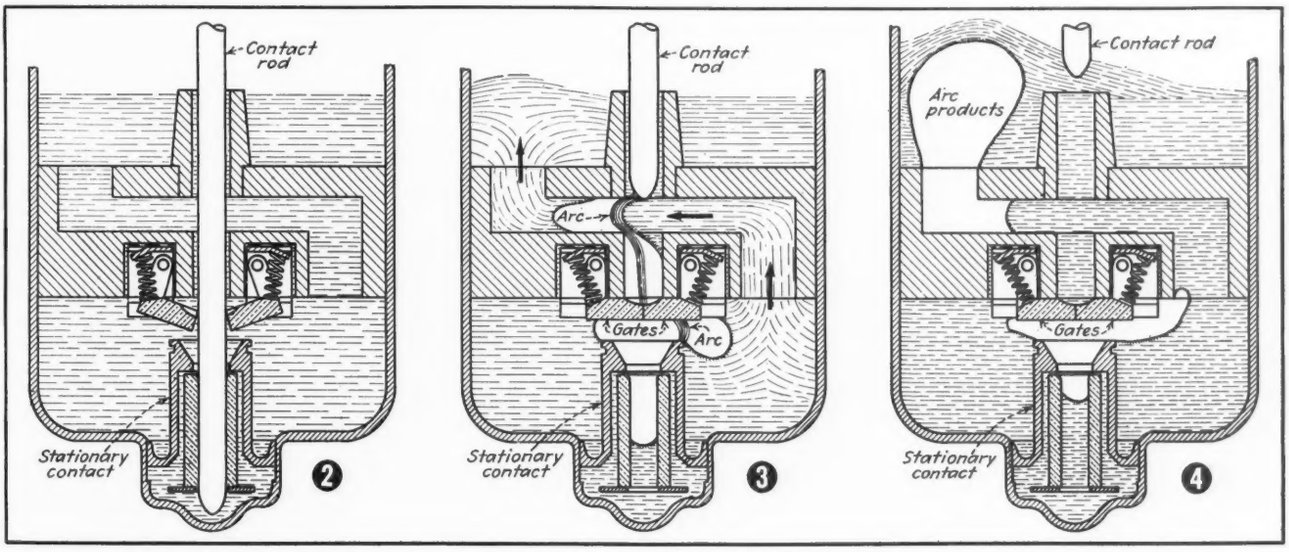
► EARLY oil circuit breakers of the plain break type, when interrupting a circuit, drew a comparatively long arc. These long arcs were objectionable because of excessive contact burning, oil deterioration and shock to the system. Most modern breakers are fitted with some kind of an arc-control device, designed to shorten the arc and reduce its duration, thereby reducing the duty on the breaker structure and lessening maintenance. Among the many so-called arc-control devices are those operating on the "blast" principle, which have been widely and successfully used for many years in different forms on various types of breakers.

To understand how the blast principle works and why it is so effective, it is necessary to know something about what happens when an alternating-current short circuit is interrupted. During the short time that short-circuit current flows and after contacts have parted, an arc voltage exists across the contacts. Each time the current reaches zero, however, when there is obviously no current flowing, the voltage across the contacts rise to a value sometimes higher than normal and then oscillate to normal. If the insulation strength of the gap between the separated contacts is insufficient, the voltage that appears across the contacts will break down the gap and current will flow.

This process will repeat until at some current zero there is enough insulation in the gap between contacts to resist breakdown by the voltage. The voltage that appears after the circuit is interrupted is called the recovery voltage. Its magnitude and rate of rise, which will vary in different systems and locations on systems, and with different kinds of interrupting devices, can be calculated from the circuit contents or measured with a cathode-ray oscillograph.

It seems obvious from the foregoing that prompt arc extinguishment depends upon how fast sufficient insulation is injected into the arc path at current zero. That is exactly what is done by breakers operating on the blast principle. In the case of oil breakers, the oil is used as the insulation. With air breakers, air is used.

In oil breakers two general methods are employed to force the oil between the contacts at current zero. (1) *The self-pressure-generating method.* In this type an arc converts oil into gas, which creates pressure sufficient to force oil through direction channels into the arc path. (2) *The impulse method,* in which the oil is forced into the arc path



Figs. 2, 3 and 4 (left to right)—Cross oil-blast circuit breaker closed, at time arc is being blasted out, and when open

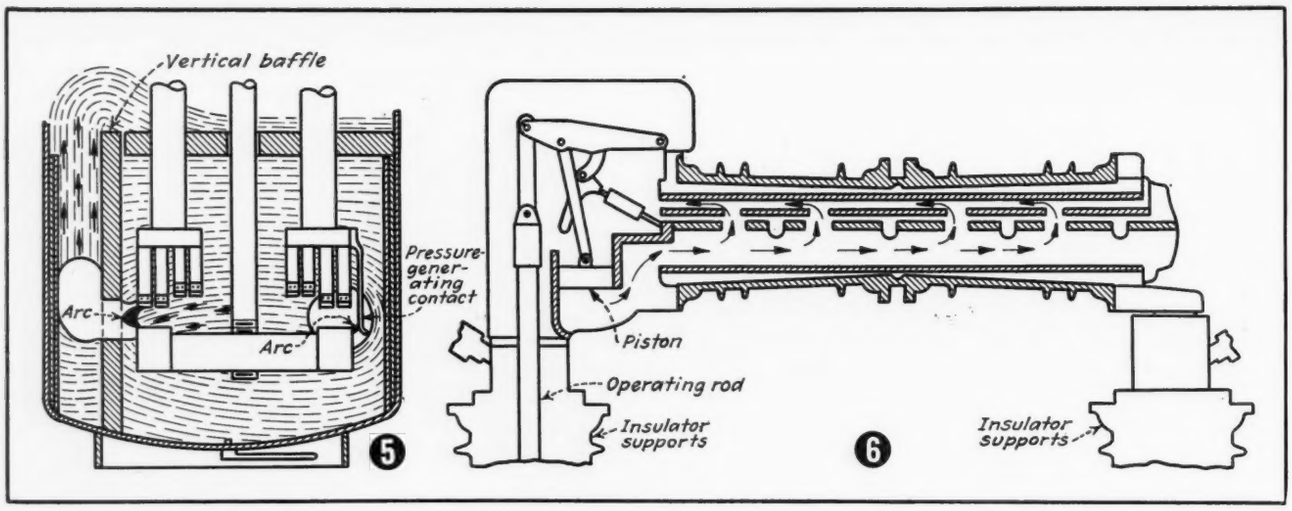


Fig. 5—Cross-oil-blast circuit breaker with vertical oil-blast baffle. Fig. 6—Impulse oil-blast circuit breaker at time of opening

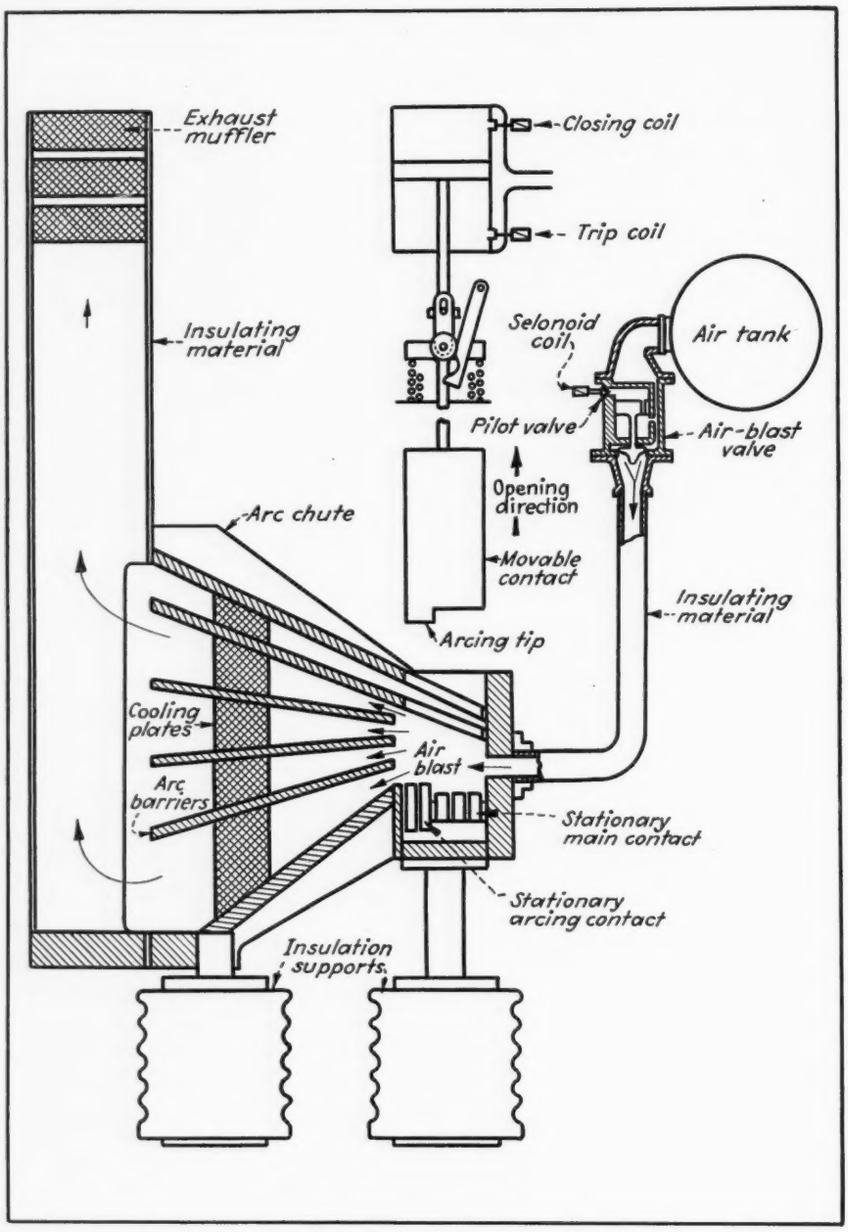


Fig. 7—Operation of air-blast circuit breaker at time of circuit interruption

by a mechanically driven piston. Each of these two methods has many variations, depending largely on the voltage, interrupting requirements and speed of operation desired.

Oil-Blast Types

Fig. 1 shows the radial self-pressure-generating oil-blast chamber. Such chambers are used on tank-type downward-break breakers of the higher-interrupting ratings and generally on the higher voltages. One such chamber immersed in oil is attached to the lower end of each bushing. The moving contact rod *R* of each chamber is attached to a conducting cross bar. Thus two chambers are in series to interrupt one phase. To interrupt a circuit, the cross bar moves downward as does the intermediate contact *C*, causing the intermediate contact to separate from the stationary contact *S* and form an arc in the top part of the oil-blast chamber. This arc decomposes oil and creates pressure in the entire chamber. As the cross head moves downward, the moving contacts separate from the intermediate contacts, which are limited in their travel.

At that time two things happen: First, an arc is formed between the intermediate and the moving contacts. Then a mixture of oil and gas from that arc is forced through the hollow moving contact rod by the pressure in the chamber, as indicated by the arrows. At current zero, when little gas is generated at the lower break, mostly oil passes through the hollow contact rod which forms high insulation between the moving and the intermediate contacts. If the moving contact has moved far enough so that the wedge of oil between it and the intermediate contact cannot be broken down by the recovery

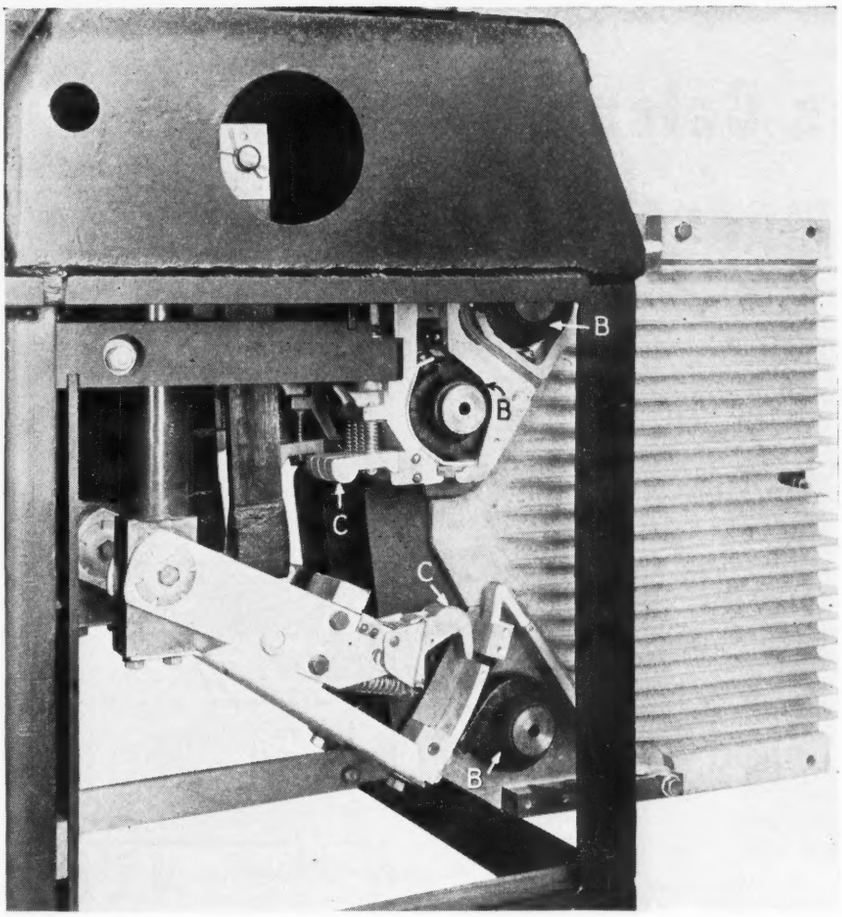


Fig. 8—A 50,000-volt Magne-blast air breaker open with half of arc chute removed

voltage, the arc stays out. If not, it continues through successive current zeros or until the oil wedge is strong enough to resist the recovery.

In self-generating blast-type breakers, only a few current zeros pass before the circuit is interrupted. As a guide to the time taken, most all breakers having radial interrupters break the circuit in substantially less than 8 cycles from the time the trip coil is energized. To do that and allow time for the trip coil to operate and the breaker mechanism to get moving, only a few half cycles remain for arc duration.

Another self-generating chamber is the cross-blast type, used on high-interrupting, heavy-current, tank breakers and on all 2-tank-per-phase upward-break breakers. Figs. 2, 3 and 4 show its application to the latter type of breaker. Fig. 2 shows the breaker closed, the circuit being completed through the contact rod and stationary contact. In Fig. 3, the contacts have separated to the location where the arc is generally extinguished.

The operation of extinguishing the arc in this breaker is similar to that described for the radial-blast chamber. The pressure-generating arc is formed between the stationary contacts and the metallic gates. This arc creates pressure which drives oil, as indicated by the arrows, across the arc path between the gates and the end of the moving contact rod. Oil flow across the arc path continually carries arc products away prior to current zero and interrupts the circuit as in Fig. 4. This action makes this type of blast chamber more effective than the radial-blast type, especially when large currents are to be interrupted. Also it can be adapted to high normal-current-carrying capacity breakers, because wipe or over-lap can be provided between the stationary and movable contacts. This permits heavy current-carrying contacts in parallel with the interrupter to be opened before arcing starts in the interrupter.

An oil-blast, Fig. 5, using a vertical baffle, is applicable primarily to 3-pole-in-1-tank downward-break breakers of ratings 15 kv and below. The contacts are enclosed in a chamber having an opening adjacent to one pair of contacts on each pole. Each pole also has a pressure-generating contact, as shown on the right. Circuit interrupting in this breaker is very much the same as that previously described. Pressure generated in the blast chamber by the arcs between the contacts forces oil out of the port openings. Oil, in passing out of the port, flows between one pair of contacts on each pole, interposing a wedge of oil at an early current zero and causing interruption.

The impulse oil-blast is used on breakers where extremely high speed of interruption is required, such as 15-kv heavy-duty railway circuits and 287-kv transmission lines. The 287-kv breakers (the highest voltage built in this country) were designed to interrupt the circuit in three cycles from the time the trip coil is energized. The actual interrupting time is substantially less than the rated time. Fig. 6 indicates how the piston drives the oil between the contacts to produce the insulation necessary to cause prompt interruption.

Air-Blast Types

Air can also be used as the interrupting medium in blast-type breakers. As is the case with oil, various forms of blast chamber may be used. Air-blast

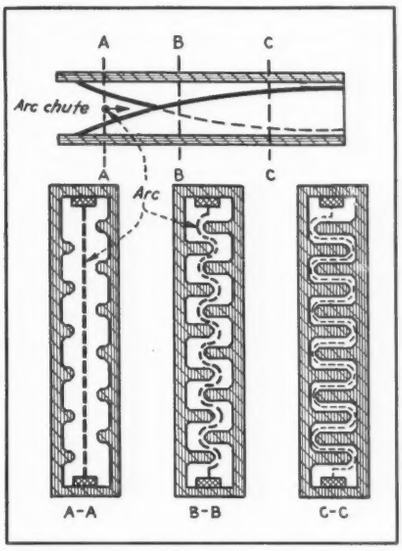


Fig. 9—Cross-sections through arc chute for the breaker, Fig. 8

breakers are a recent development in this country. Their largest application to date has been to indoor heavy interrupting service at 15,000 volts. Fig. 7 shows a section of the blast chamber of one pole of such a breaker, which is of the cross-blast type.

The arc chute and its barriers are of insulating material. Cooling plates in the chute are metal, designed to cool the arc products as they pass through the plates and also to suppress noise. When interrupting a circuit, the moving contact travels upward from the stationary contact. Before the contacts have parted, a blast of air is directed across the contacts into the chute, which

(*Continued on page 138*)

Stress Calculation for High-Temperature Piping—I

Simplified process provides an exact solution for the reactions of a three-dimensional piping system subjected to expansion

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▶ DETERMINATION of the reactions set up by thermal expansion of a 3-dimensional pipeline takes much time and is an exacting task. The procedure presented in this article can be executed with little effort as indicated by the fully worked out numerical example of a typical piping system. The proof of the method is omitted; those familiar with similar computation methods will recognize that the solution obtained is exact.

The reactions set up at each end of a fully restrained pipeline consist of three component forces and three component couples. General analytical theory furnishes six equations for finding these unknown quantities but involves the predetermination of 21 dissimilar coefficients.

If, however, one end is made free and its reactions are transferred to the centroid of the system by a temporary, rigid, bracket, the couples disappear and the unknowns are reduced to three, namely three forces at the centroid. The unknown coefficients are reduced to six. The general equations can then be written in the following form:

$$+XI_x - YI_{xy} - ZI_{xz} = \Delta xEI$$
$$-XI_{xy} + YI_y - ZI_{yz} = \Delta yEI$$
$$-XI_{xz} - YI_{yz} + ZI_z = \Delta zEI$$

where

Δx, Δy, Δz, are the component expansions,

X, Y, Z, are the component forces acting, opposite to the component expansions

I_x, I_y, I_z denote the moments of inertia of the line about the x, y, and z axes,

I_{xy}, I_{xz}, I_{yz} denote the products of inertia in respect to the axes indicated by the subletters,

E is the modulus of elasticity.

The line is considered successively as though projected into the three planes of a right-angled coordinate system. Fig. 1 represents a 3-dimensional pipeline. Fig. 2 is its projection in the x-y plane. In the latter, branches ab and bc appear in their true length and branch cd as a point. In figuring the centroid, the length of the latter (whichever line appears as a point) is multiplied by 1.3 to account for the difference between the modulus of rigidity in torsion and the modulus of elasticity in bending.

Moments of Inertia

The moment of inertia of a branch located at right angles to an axis (as for example, line ab about axis x) is:

$$I_x = \frac{p_1}{12} + l_1 y_1^2$$

The moment of inertia of the same branch about an axis parallel to it is:

$I_y = l_1 x_1^2$

The moment of inertia of a branch at right angles to the plane of projection (as for example cd) is:

$I_x = 1.3 l_3 y_3^2$ and

$I_y = 1.3 l_3 x_3^2$

where l is the length of the line and x, y, and z denote distances in feet as indicated in Fig. 2.

The product of inertia equals length of branch multiplied by the coordinates of its centroid:

for ab $I_{xy} = l_1 x_1 y_1$

for cd $I_{xy} = 1.3 l_3 x_3 y_3$

With the foregoing introduction, the mechanics of the method can be readily followed in the numerical problem of Fig. 3. Note that the signs in all equations conform to the directions assumed for the axis of the coordinate system indicated in Fig. 1.

For convenience and orderly procedure, sketches of the pipeline projected into the three planes and the corresponding computations relating to these planes are done in three vertical rows in Fig. 3. The procedure is: (1) determine the centroid, the products of inertia and the moments of inertia (note that each moment of inertia consists of two parts obtained from two different planes, for example, one I_z is obtained from the xy plane and one from the xz plane, and these must be added). (2) Introduce coefficients in the three general equations and solve for X, Y, and Z (3) transfer reactions X, Y, and Z to actual end of line and obtain the reacting couples.

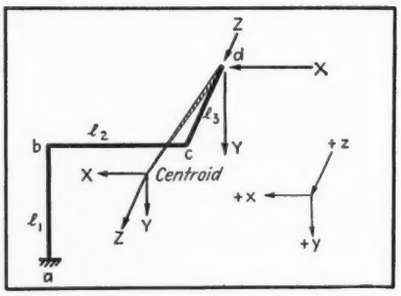


Fig. 1—By referring all forces to the centroid, end reactions can be calculated from three equations

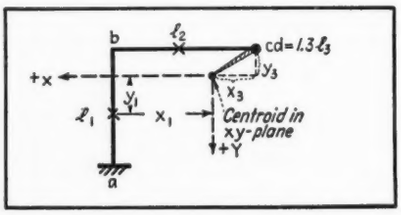
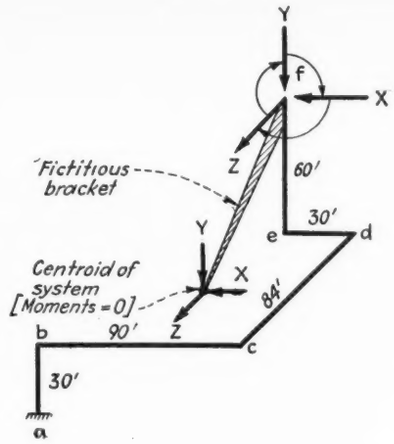


Fig. 2—Computations are first made for each plane, then combined

Editor's Note: The foregoing computation applies to short-radius elbows and welded fittings. A similar computation for curved bends will appear in the February issue of POWER.

Fig. 3—Form for orderly computation of completely worked out numerical example of piping system having short-radius ells



X, Y, Z... *Reactions and directions of positive x, y, z axes*

24" Pipe Sched 80 I = 5673 in⁴
Temp 750 F Expansion 6.25"/100 Ft

$\Delta X = \frac{6.25''}{100} \times (90' - 30') = 3.75''$

$\Delta Y = \frac{6.25''}{100} \times (60' + 30') = 5.62''$

$\Delta Z = \frac{6.25''}{100} \times 84' = 5.25''$

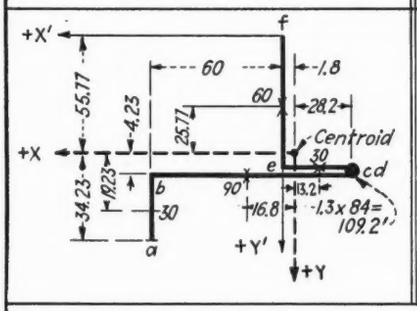
$\Delta x\,EI = \frac{3.75}{12} \times 25 \times 10^6 \times 5673 \times \frac{1}{144} = 308,000,000$

$\Delta y\,EI = \frac{5.62}{12} \times 25 \times 10^6 \times 5673 \times \frac{1}{144} = 460,000,000$

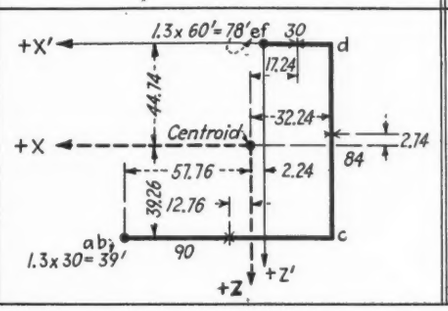
$\Delta z\,EI = \frac{5.25}{12} \times 25 \times 10^6 \times 5673 \times \frac{1}{144} = 430,000,000$

PROJECTION IN

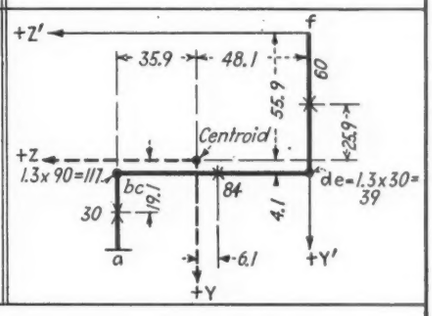
XY - Plane



XZ - Plane



YZ - Plane



CENTROID

	ℓ	x'	ℓx'	y'	ℓy'
ab	30	60	1,800	75	2,250
bc	90	15	1,350	60	5,400
cd	109.2	-30	-3,276	60	6,550
de	30	-15	- 450	60	1,800
ef	60	0	0	30	1,800
	319.2'		- 576		17,800

$-\frac{576}{319.2} = -1.8'$ $\qquad \frac{17,800}{319.2} = 55.77'$

	ℓ	x'	ℓx'	z'	ℓz'
ab	39	60	2,340	84	3,276
bc	90	15	1,350	84	7,560
cd	84	-30	-2,520	42	3,528
de	30	-15	- 450	0	0
ef	78	0	0	0	0
	321'		+ 720		14,364

$\frac{720}{321} = 2.24'$ $\qquad \frac{14,364}{321} = 44.74'$

	ℓ	y'	ℓy'	z'	ℓz'
ab	30	75	2,250	84	2,520
bc	117	60	7,020	84	9,828
cd	84	60	5,040	42	3,528
de	39	60	2,340	0	0
ef	60	30	1,800	0	0
	330		18,450		15,876

$\frac{18,450}{330} = 55.9'$ $\qquad \frac{15,876}{330} = 48.1'$

I_{xy}

	ℓ	x	y	ℓxy
ab	30	61.8	19.23	+35,700
bc	90	16.8	4.23	+ 6,400
cd	109.2	-28.2	4.23	- 13,450
de	30	- 13.2	4.23	- 1,670
ef	60	1.8	-25.77	- 2,750

$I_{xy} = +24,230$

I_{xz}

	ℓ	x	z	ℓxz
ab	39	57.76	39.26	+88,400
bc	90	12.76	39.26	+45,080
cd	84	-32.24	- 2.74	+ 7,420
de	30	-17.24	-44.74	+ 23,100
ef	78	- 2.24	-44.74	+ 7,800

$I_{xz} = +171,800$

I_{yz}

	ℓ	y	z	ℓyz
ab	30	19.1	35.9	+ 20,570
bc	117	4.1	35.9	+ 17,200
cd	84	4.1	- 6.1	- 2,100
de	39	4.1	-48.1	- 7,680
ef	60	-25.9	-48.1	+ 74,750

$I_{yz} = +102,740$

I_x and I_y

I_x	ab	$\frac{30^3}{12} + 30 \times 19.23^2 = 13,400$
	bc	$90 \times 4.23^2 = 1,615$
	cd	$109.2 \times 4.23^2 = 1,955$
	de	$30 \times 4.23^2 = 540$
	ef	$\frac{60^3}{12} + 60 \times 25.77^2 = 57,700$
		$I_x = 75,210$
I_y	ab	$30 \times 61.8^2 = 114,500$
	bc	$\frac{90^3}{12} + 90 \times 16.8^2 = 86,250$
	cd	$109.2 \times 28.2^2 = 87,000$
	de	$\frac{30^3}{12} + 30 \times 13.2^2 = 7,400$
	ef	$60 \times 1.8^2 = 195$
		$I_y = 295,345$

I_x and I_z

I_x	ab	$39 \times 39.26^2 = 60,000$
	bc	$90 \times 39.26^2 = 138,800$
	cd	$\frac{84^3}{12} + 84 \times 2.74^2 = 50,230$
	de	$30 \times 44.74^2 = 60,000$
	ef	$78 \times 44.74^2 = 156,000$
		$I_x = 465,030$
I_z	ab	$39 \times 57.76^2 = 130,000$
	bc	$\frac{90^3}{12} + 90 \times 12.76^2 = 75,350$
	cd	$84 \times 32.24^2 = 87,500$
	de	$\frac{30^3}{12} + 30 \times 17.24^2 = 11,180$
	ef	$78 \times 2.24^2 = 390$
		$I_z = 304,420$

I_y and I_z

I_y	ab	$30 \times 35.9^2 = 38,700$
	bc	$117 \times 35.9^2 = 150,800$
	cd	$\frac{84^3}{12} + 84 \times 6.1^2 = 52,500$
	de	$39 \times 48.1^2 = 90,000$
	ef	$60 \times 48.1^2 = 139,000$
		$I_y = 471,000$
I_z	ab	$\frac{30^3}{12} + 30 \times 19.1^2 = 13,194$
	bc	$117 \times 4.1^2 = 1,967$
	cd	$84 \times 4.1^2 = 1,412$
	de	$39 \times 4.1^2 = 656$
	ef	$\frac{60^3}{12} + 60 \times 25.9^2 = 58,248$
		$I_z = 75,477$

Sum of $I_x = 75,210 + 465,030 = 540,240$
" " $I_y = 295,345 + 471,000 = 766,345$
" " $I_z = 304,420 + 75,477 = 379,897$

$$540,240\,X - 24,230\,Y - 171,800\,Z = 308,000,000$$
$$-\,24,230\,X + 766,345\,Y - 102,740\,Z = 460,000,000$$
$$-\,171,800\,X - 102,740\,Y + 379,897\,Z = 430,000,000$$

$X = 1,225$ lbs $\qquad Y = 895$ lbs $\qquad Z = 1,920$ lbs

Reacting couples at "f"

in XY-Plane:
+1225 lbs x 55.77' + 895 lbs x 1.8' = 69,810 Ftlbs

in XZ-Plane:
+1225 lbs x 44.74' - 1920 lbs x 2.24' = 50,500 Ftlbs

in YZ-Plane:
-895 lbs x 48.1' + 1920 lbs x 55.9' = 64,000 Ftlbs

Clean Diesel Oil Lasts Longer

Small diesel plants as well as big can cut operating costs by properly filtering and purifying lube oil — it's all in knowing how. S S Hansen, chief lubrication engineer of General Petroleum Corp, gives a practical guide to methods and equipment for mechanical purification

▶ No DIESEL-PLANT operating engineer can afford to overlook the attractive savings possible through lengthening the life of lubricating oil by proper purification and filtration, even though lube-oil costs are not a major item when compared with other operating costs such as fuel and labor.

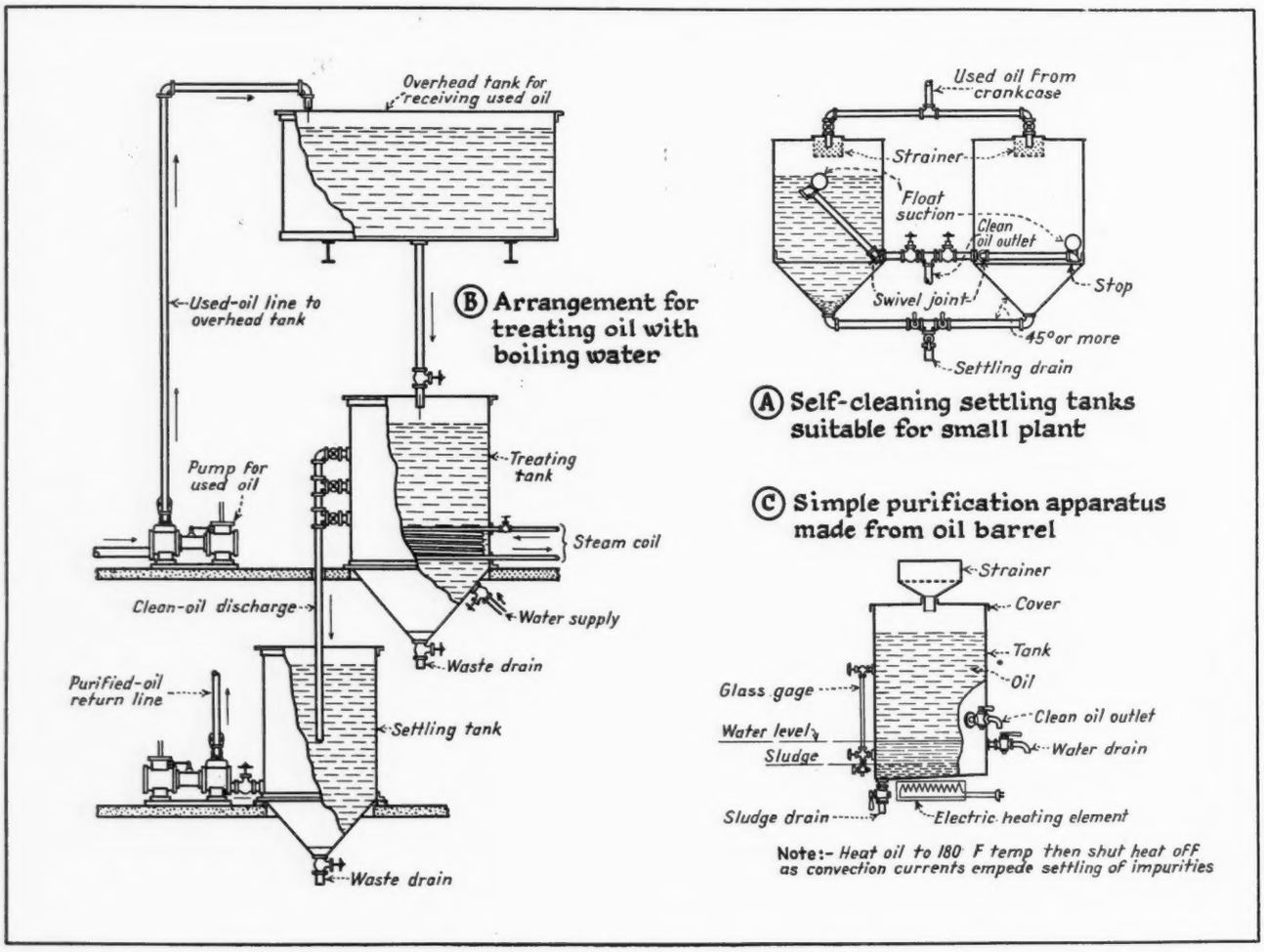
During the past three or four years, filter manufacturers, engine builders and oil refiners have given increasing attention to purification practices. Searching through the welter of statements and counter-statements, the plant engineer is apt to find confusion instead of the true facts. This article attempts to bring some order into the chaos by classifying and explaining the generally accepted means of purification and filtration, and indicating their fields of usefulness.

Crankcase oil needs purification because, in service, it goes through physical and chemical changes which impair its usefulness. Various byproducts of combustion form in the cylinder and, in continuous service, leak by the piston rings and gain entry to the lubricating oil. These impurities include water, carbon particles and soot, and heavier unburned portions of the fuel. Corrosive gases form, which include hydrogen sulphide and carbon dioxide. These combine with water to form sulphurous and sulphuric acid, and carbonic acid. Formaldehyde and other aldehydes appear. These latter may not be present in serious quantities except under poor combustion conditions, and may not appreciably affect the crankcase oil unless piston rings are worn.

Serious contamination of lubricating oil comes from dust and dirt entering the air-intake system. In addition, considerable quantities of air enter the crankcase through the breathers. Since much of the oil in the crankcase is present as a mist or fog, impurities are washed from the air and entrained in the circulating system.

Hot oil, circulating through the diesel system, picks up metallic oxides

Fig. 1—Three batch settling-tank arrangements



(iron and copper, usually) which act as powerful catalytic agents in hastening chemical change and breakdown of lubricating oil. These materials need only occur in small fractions of 1% to cause serious damage. Particularly during the break-in period, the circulating oil may pick up metallic particles or traces of core sand. In some cases, impurities left after the refining process may contaminate new oil. These include acids, alkalies, and solvents.

Sludge Formation

Constant circulation and contact with hot engine parts causes lubricating oils to oxidize, forming organic acids and sludges. Chemically, sludge may be defined as precipitated oxidized hydrocarbons. However, other physical contaminants, previously mentioned, enter into the composition of the sludge and change its character appreciably. Sludges may differ in appearance from a soft liver-like mass to a dry punk-like material. Sludge is most undesirable in the system as it deposits over pump screens, though drilled crankshafts and connecting rods, and in valve chambers. It precipitates in oil coolers and builds up an insulating layer which seriously impedes heat transfer. In 2-cycle engines, sludge builds up in scavenging-air ports and interferes with proper cylinder scavenging.

The amount of sludge formed depends primarily on the mechanical condition of the engine and the severity of operation. Some lubricants resist sludge formation better than others, but the mechanical design and condition of the engine constitutes the predominating factor in sludge formation.

Three Ways to Purify

There are three general methods of purifying diesel-engine lubricating oil: (1) batch purification, (2) continuous total purification, and (3) continuous bypass purification. The first, usually accomplished by batch settling tanks, provides for complete removal of the oil charge and settling out of impurities over a sufficient period of time. Complete purification of the oil charge once during each circulation is possible in some engines, particularly when rate of circulation is not rapid. Continuous bypass purification provides for removing a portion of the dirty oil and bypassing it through a cleaning device. In many cases, about 10% of the total volume of oil in the circulatory system is bypassed continuously.

Equipment for oil purification may handle the job in any one of three basic ways: (1) by removing impurities mechanically, (2) by absorbing impurities, and (3) by chemical treatment. This article will deal only with mechanical purification; a later article will cover the remaining methods. Equipment for mechanical purification includes various types of batch settling tanks, centrifuges, cotton- or wool-waste filters, and edge filters.

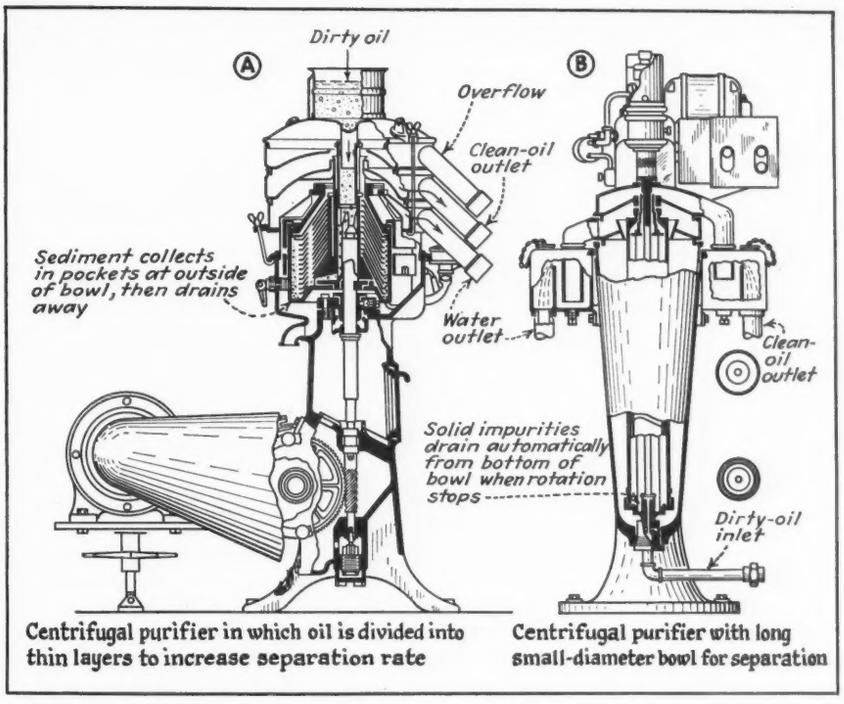

Dirty oil
A
B
Overflow
Clean-oil outlet
Sediment collects in pockets at outside of bowl, then drains away
Water outlet
Clean-oil outlet
Solid impurities drain automatically from bottom of bowl when rotation stops
Dirty-oil inlet
Centrifugal purifier in which oil is divided into thin layers to increase separation rate
Centrifugal purifier with long small-diameter bowl for separation

Fig. 2—(A) Oil in this centrifugal purifier is divided into thin layers by disks to increase rate of separation. (B) Centrifuge with long, small-diameter bowl in which oil is separated from impurities, forming thin annular layers

Batch settling is best accomplished by pumping the oil into the batch settling tank at the operating temperature of the crankcase and providing for a period of undisturbed rest. Impurities with specific gravity higher than that of oil will slowly precipitate out and settle to the bottom. Because products of oxidation, soluble while hot, become less soluble as the oil cools, batch settling effectively removes organic acids from lube oil and thus improves its neutralization number.

Fig. 1 shows three batch-settling-tank arrangements. The self-cleaning tanks (A) fit small-plant conditions well. The heavier sludge particles and dirt accumulate at the bottom of the tank, in the apex of the cone. Water accumulates as an intermediate layer between sludge and the clean oil at the top. A somewhat more elaborate system (B) provides for treating the used oil with boiling water. When the oil becomes thoroughly agitated, the heat should be shut off. Drops of water precipitating downward out of the oil aid in washing it free of impurities.

The engineer of the average small plant can construct a simple and inexpensive purification apparatus (C) by using an old oil barrel. A series of three or four drain cocks welded to the side of the barrel at various levels provide for removal of clean oil. A screen at the top of the barrel removes coarse impurities; a sight glass at the side allows the operator to see the condition of the oil. Used oil from the crankcase, when first introduced, should be heated to about 180 F by means of the electric heating element. This thins the oil and speeds settling of entrained impurities. However, heating to more than 180 F will set up convection currents in the oil which hinder precipitation.

Centrifuging

Like settling processes, centrifugal purification effects separation by utilizing the differences in the specific gravity of oil and impurities. Centrifugal action simply changes the separation from the vertical to the horizontal plane, which means that heavier sludge particles are thrown to the outside of the centrifuge bowl, where they are caught in sediment pockets and drained away. Water discharges through an intermediate spout (Fig. 2A) while clean oil flows from the top spout. The centrifugal action, many thousand times greater than gravity, insures clean and complete removal of the higher specific-gravity impurities.

In the centrifuge of Fig. 2A, the bowl,

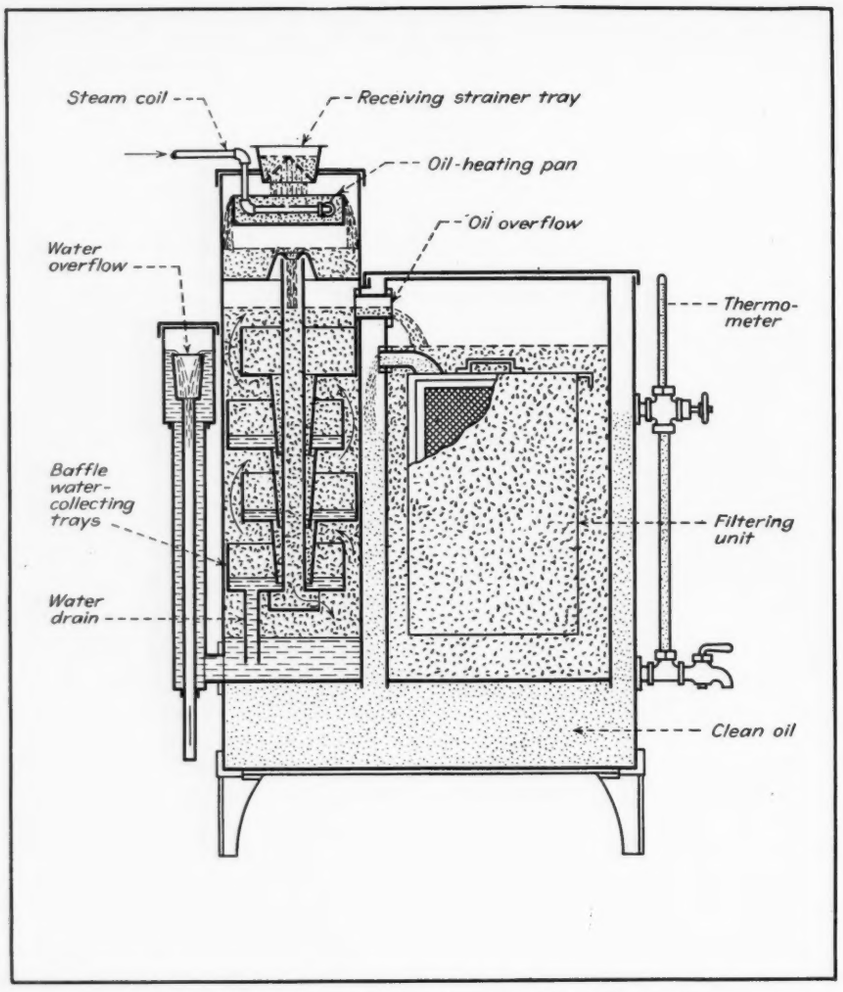


Fig. 3—Typical gravity filter for diesel lubricating oils

mounted on a vertical shaft, rotates at high speed. Dirty oil enters at the top and passes beneath a series of conical plates. It flows upward through holes cut in each plate, spreading in thin layers toward the apex of each cone. Impurities separate from these thin layers more readily than they could from bulk oil, but warming the oil makes purification still easier.

Different Centrifuge

A centrifuge of different design is shown in Fig. 2B. This features a long vertical tubular bowl, rotated at high speed. Oil enters the bowl at the bottom. The strong centrifugal force developed keeps the liquid moving at the annular speed of the centrifuge and prevents turbulence. By distributing itself in thin layers the oil places its impurities under maximum influence of the centrifugal force. Purified oil and water discharge from separate spouts; solid impurities stay in the bowl until the rotation stops, when they automatically drain away.

Rate of feeding oil through a centrifuge must be suited to the character and amount of contamination; if feed is too rapid, only partial purification may result. The engineer must study this condition to adjust properly rate of flow. Purification bowls must be cleaned from time to time and dirt removed from sediment pockets.

Adding water to the lubricating oil passing through a centrifuge can sometimes do more harm than good if the centrifuge does not completely remove the water. Before adopting this practice, the advice of experienced lubrication engineers should be secured. Because acidic compounds in the contaminated lubricating oil have approximately the same specific gravity as the oil, making them difficult to remove in a centrifuge, it is highly desirable to combine both batch settling and centrifuging for complete purification. The acidic materials become less soluble at lower temperatures and can, therefore, be more completely removed by settling.

Gravity filters constitute another form of mechanical purification; these may be subdivided into wet and dry types. In the former, contaminated oil passes through a charcoal or an animal bone-black filtering element and then to the bottom of a water column. The drop of oil floats upward through the water, the theory being that the impurities will be effectively washed away by the water. Actually, this seems to have little effect, inasmuch as the majority of the impurities in the oil are inside the drop and so not affected by passage through the water.

Gravity Filter

Fig. 3 shows a typical gravity filter for diesel lubricating oils. Dirty oil enters through a removable strainer at the top, where coarse impurities (such as waste and scale) are eliminated. The oil then passes to a heating tray. A vertical tube conducts the thinned oil to the bottom of a precipitation chamber; the oil then works its way upward between several precipitation trays, leaving behind some of its impurities and all entrained water.

In the filtration compartment the partially purified oil passes through metal filter frames, each of which carries two sheets of wire screen covered with filter cloth. After filtering, oil flows to a clean-oil compartment for cooling and storage. From time to time, filter cloths and screens become fouled, making effective purification impossible. Filtration materials should be replaced or cleaned before a decrease in the purity of the filtered oil, or a retarding of the filtering process, becomes serious.

Absorbent filters utilize as filtering mediums cotton fibre, yarn, waste or other materials of this nature. If the filter is located on the discharge side of the oil pump it is called a *positive-pressure* filter; if located on the suction side of the pump it is called a vacuum filter. A pressure filter, utilizing cloth or fabric as filtering medium, appears in Fig. 4A. The filtering cloth is spaced by a flexible metallic netting, which accomplishes the dual purpose of spacing and providing a storage receptacle for the entrained sludge. Dirty oil enters at the bottom and follows the path indicated by the arrows. Clean oil discharges at the bottom. A bypass valve, held on its seat by spring tension, provides for bypassing the oil if the filter clogs.

Cloth Filter

In the filter shown in Fig. 4B, contaminated oil enters the cylindrical housing at the top. It flows around the filter cloth, which is held in its position at the center by two helical springs. The filter cloth completely covers the springs, each of which has a different diameter. This gives the filtering element a thread-shaped appearance and the area between the threads provides

ample filtering capacity. As a layer of sludge accumulates over the filter cloth, filtering effectiveness increases but at the same time filtering capacity begins to fall off.

Edge Filters

The final group of mechanical purification devices includes edge filters of various kinds. Fig. 4C shows such a unit, in which dirty oil under pressure enters the top of the filter and flows into the cylindrical housing. It is forced through close clearance spaces between a stack of cylindrical metal disks, separated by thin spacers. Spacer thickness governs degree of filtration. A layer of sludge on the outside of the disks improves filtering effectiveness but as was the case with the filter mentioned above, the sludge layer retards the flow. Fitted between each metallic disk and surrounding its outside periphery is a knife-blade arrangement, rotated by a handle outside the housing. This scheme provides for easy removal of the accumulated layer of sludge, which drops into a reservoir at the bottom of the housing.

The filter in Fig. 4D consists of a series of washer-shaped treated-paper disks, held in close contact in a cylindrical stack by spring tension. Degree of filtration depends on the pressure with which the spring holds the disks together. Oil enters the filter housing at the bottom and forces its way through the interstices between the disks. Filter capacity depends on number of cylindrical stacks provided, and varies from 2 to 200 gal per hour. Admission of air at the top, through the center of the stack, cleans the filter. Air pressure causes the accumulated sludge to drop to the bottom where it can be drained away.

Bypass Operation

The filters shown in Fig. 4 are all of the bypass type and, on the average, filter approximately 10% of the crankcase contents during any one cycle. This low ratio is necessary to insure sufficient flow to the bearings at all times. The wide difference in amount of oil flowing on each cycle and amount being filtered must be considered. For example, if crankcase capacity is 10 gal, the ratio of oil being filtered to that reaching the bearings is 1 to 10. In other words, dirty oil has a 10 to 1 chance of reaching the moving parts before being removed by filtration.

None of the mechanical filters, with the possible exception of the paper-disk type, removes colloidal carbon effectively, so that an oil blackened by presence of colloidal carbon may still be black after passing the filter. This does not necessarily mean that the oil is not in good condition for continued service; the amount of colloidal carbon which will blacken oil is extremely small and does not adversely affect the service value. It may, however, affect the engine operator's opinion, especially when compared with results from purifiers which do remove colloidal carbon. It is only natural that the operator should be more favorably impressed by a clear bright oil than by a black oil, regardless of the effectiveness of the two products in service.

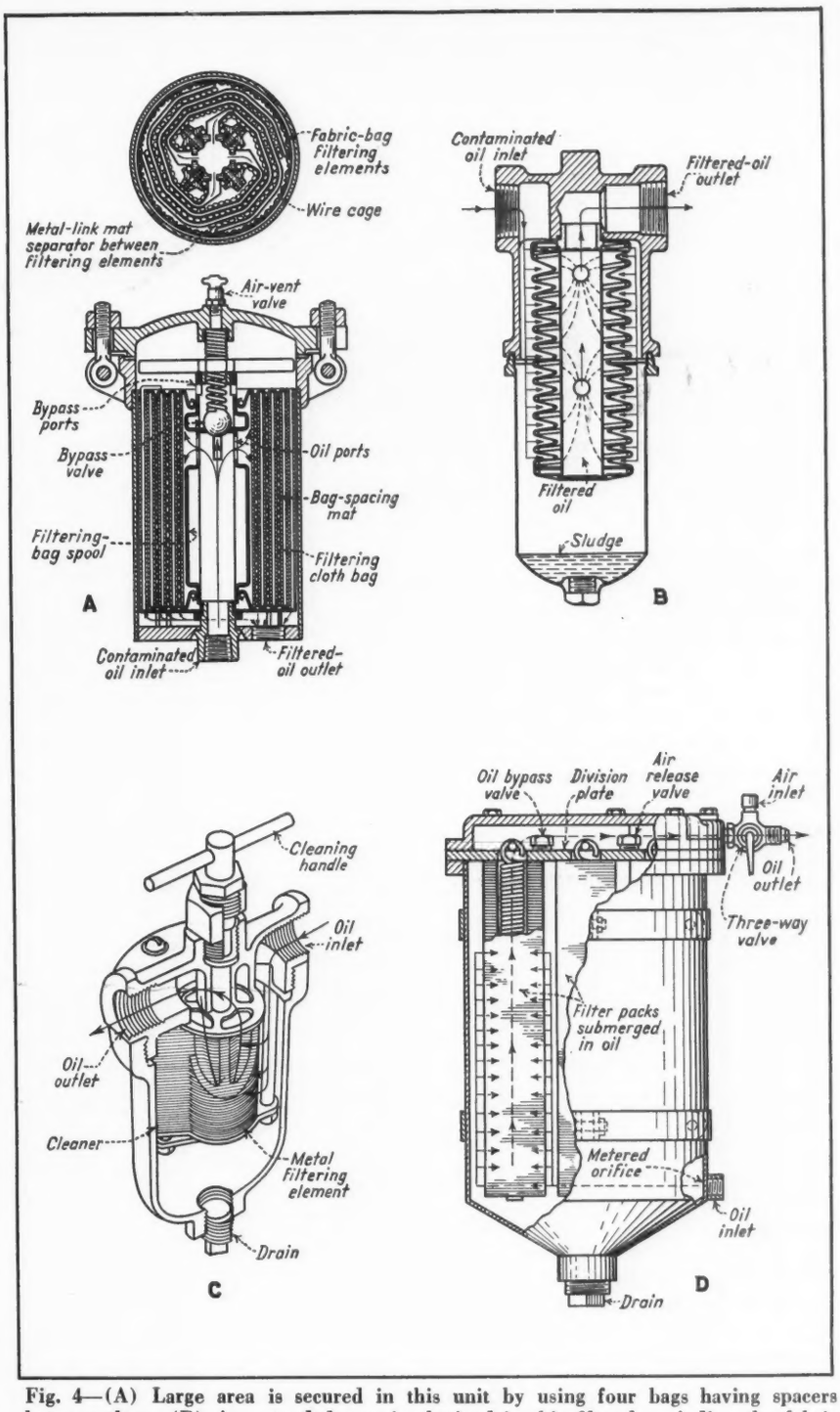


Fig. 4—(A) Large area is secured in this unit by using four bags having spacers between them. (B) An extended area is obtained in this filter by winding the fabric filtering cloth over two helical springs of different diameters. (C) Filtering elements consist of a stack of closely spaced metal disks. (D) Stacks of special paper disks held by helical springs filter the oil in this design

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Imagination was given a man to compensate him for what he is not, and sense of humor was provided to console him for what he is.—POWERFAX.

Arc Welding Speeds Stack Top Construction

Fortunately for both POWER and its readers, Clayton M Allen, Assistant Mechanical Engineer of the Los Angeles Bureau of Power & Light, has an alert finger on the camera trigger. His many fine photos give us the chance to present a story in pictures showing how electrically welded rings replaced riveted sections on top 111 ft of seven 200-ft stacks at Alameda Station

▶ "TOPPING" a steam power plant sometimes means adding a new high-pressure turbine but here it meant lifting 100 tons of steel in place from the roof of a boiler house. The job was done by the regular crew of the 70,000-kw Alameda plant; free use of torch and arc in removing 18-year-old corroded stack rings developed many practical, time-saving and ingenious methods.

Old corroded stack rings were in 5-ft heights. Seven of the new ¼-in. thick rings were made 8 ft high to reduce cost. Top eleven rings of $\frac{3}{16}$-in. plate were 5 ft high and the uppermost five sections were fabricated in halves to facilitate erection. A 3-in. butt strap was welded to the bottom of each ring by a single outside lap weld.

Shop welding by shielded arc employed a back-up strap if single-pass machine welded and a two-pass technique with no strap if by hand. Each ring had four temporary tack-welded tee clips with a ¾-in. hole in the outstanding leg for handling and for inside working-scaffold hanger supports. A ⅛-in. spacer on each clip kept open the butt joint between sections for field welding.

Handling Top Sections

For handling the top 25-ft, a modified jenniwink was fabricated from iron pipe supported by a platform suspended inside the stack. Lower sections were handled by welded A-frames set on the top stack bracing and supported by temporary wood shoring. Gasoline-driven double-drum winches controlled load lines going through "pass" holes or over the top of the stack through special steel sheave blocks.

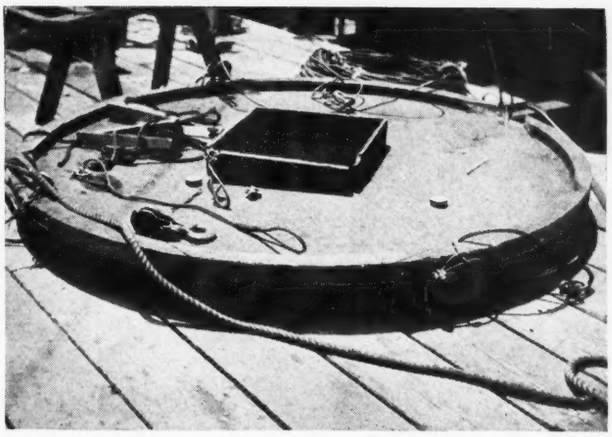
After tack-welding enough to hold the weight of the next couple of sections, inside welding was carried on from the lower level of a tandem platform except for short intervals when the next ring was actually being placed.

A ⅜ x 3-in. ring, welded at the extreme top of the stack and projecting ½-in. above the stack plate, forms a permanent track for the tiller-rope pulley. U-bolts and hooks for guys were attached by welding at the exact location for most effective rigging, temporary or permanent, in less time than was required for deciding on their locations.

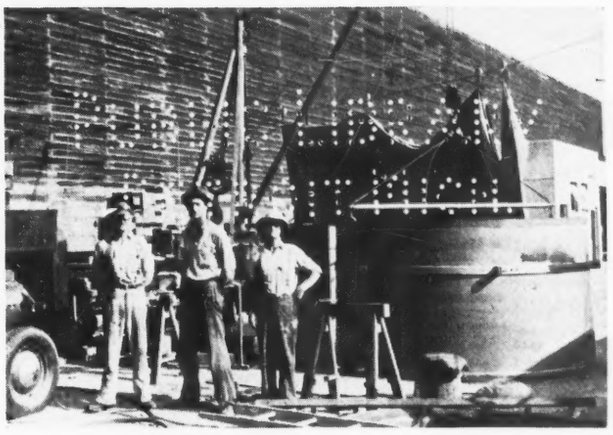
Fabrication of the stack sections was contracted to the Southwest Welding and Mfg Co in Alhambra, Calif., and Ferrabon gun-metal stack paint was supplied by Scriver & Quinn.

Design specifications were prepared by W A Shelton under the supervision of W C Rowse and C P Garman. Construction operations were directed by C W Ragan under the supervision of R R Robertson and G E Benkesser.

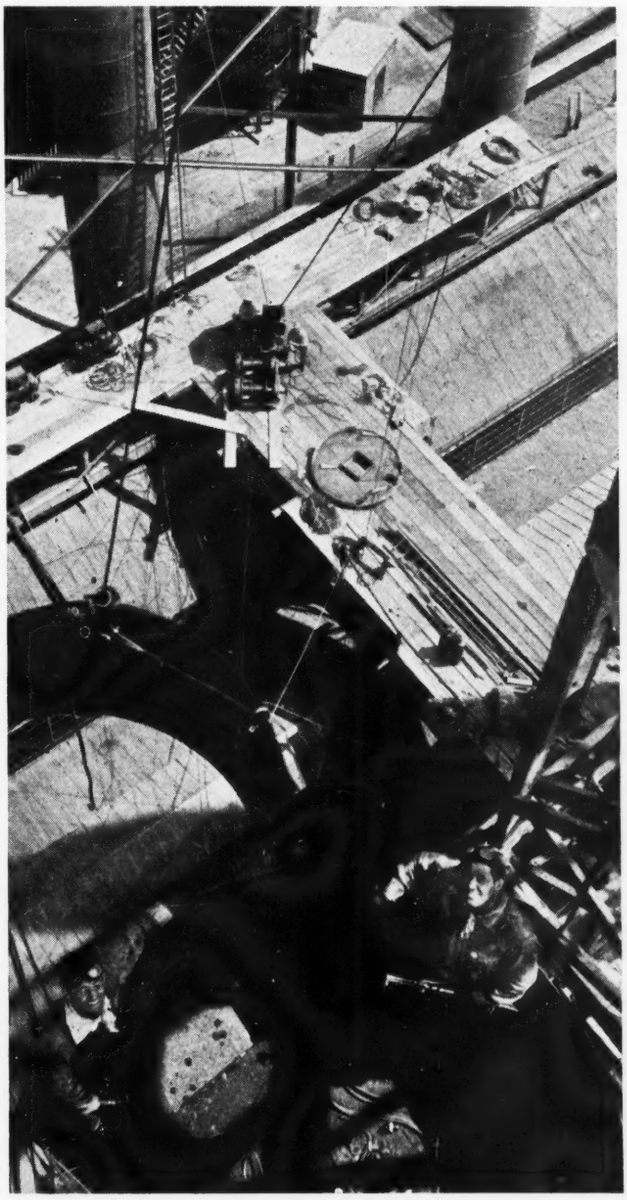
1—Flame-cutting upper sections of 8½-ft diameter stack from inside platform. Periodic drilling of test holes showed corrosion had eaten away more than half the original thickness



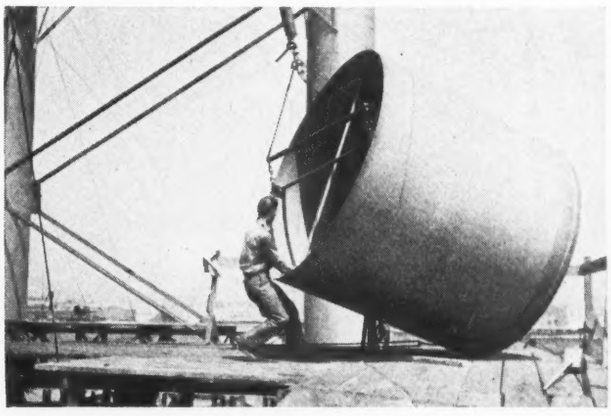
2—Upper half of two tandem work platforms used inside the stacks. Lower half of stack, of $\frac{5}{16}$-in. plate and not badly corroded, was sandblasted inside, then painted inside and out



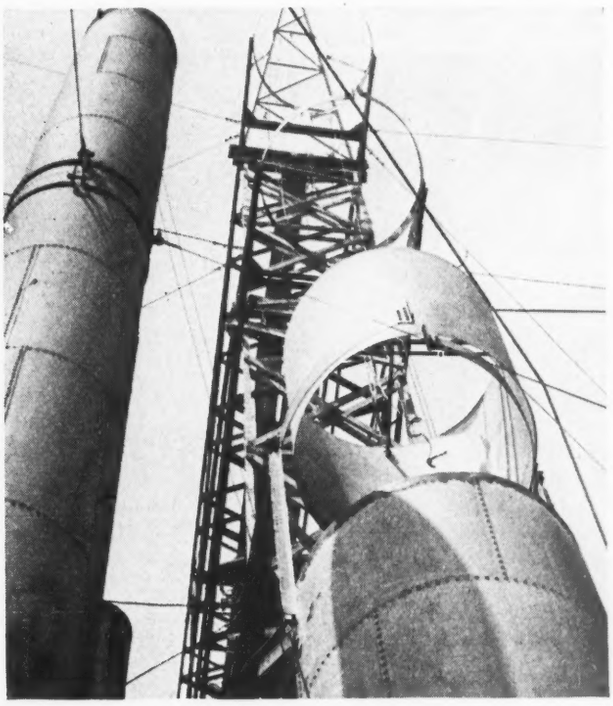
4—New shop-welded rings, delivered by truck, were provided with welded guy attachments and butt straps before being hoisted to working platform on the roof



3—Carefully planned procedure for dismantling insured safety and continuity of the job. Structural bracing, cut free as sections were removed, was replaced by temporary shoring

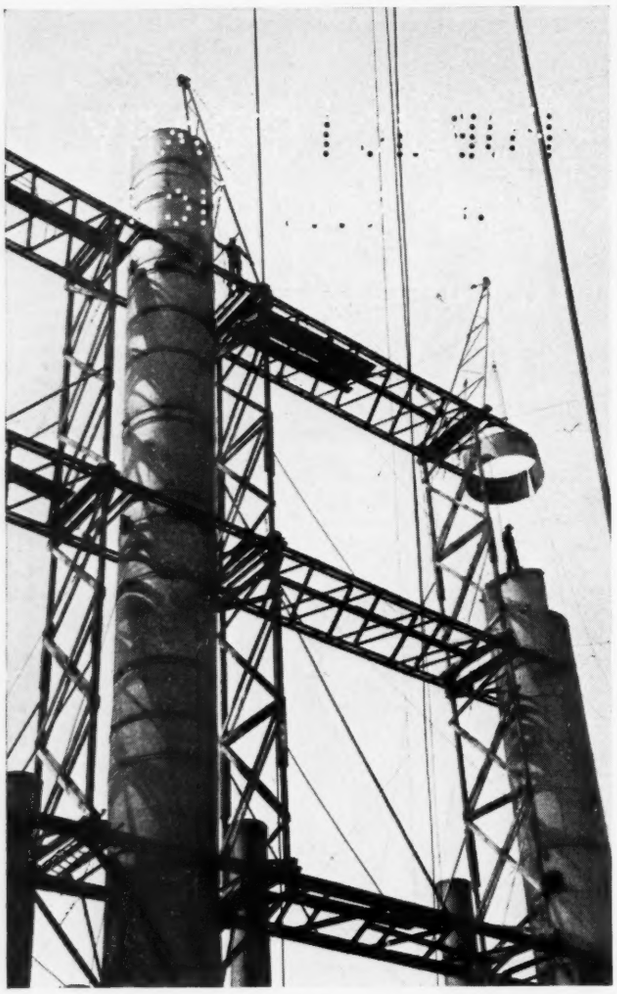


5—Sections were rolled along roof platform, then stood on end for lifting. Note lifting bail, spreaders, temporary lugs



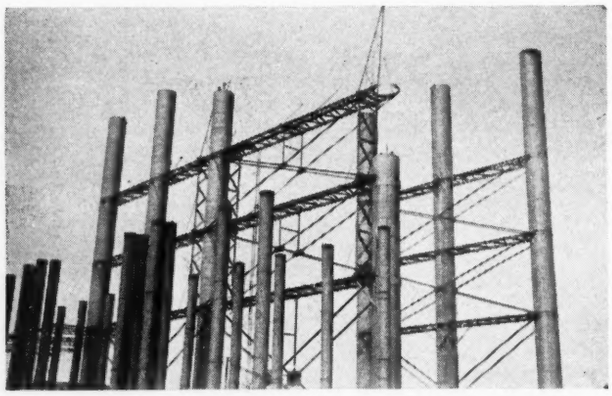
6—Setting first new welded section on top of lower portion of riveted stack left in place. Note structural horizontal stack bracing

(CONTINUED ON NEXT PAGE)

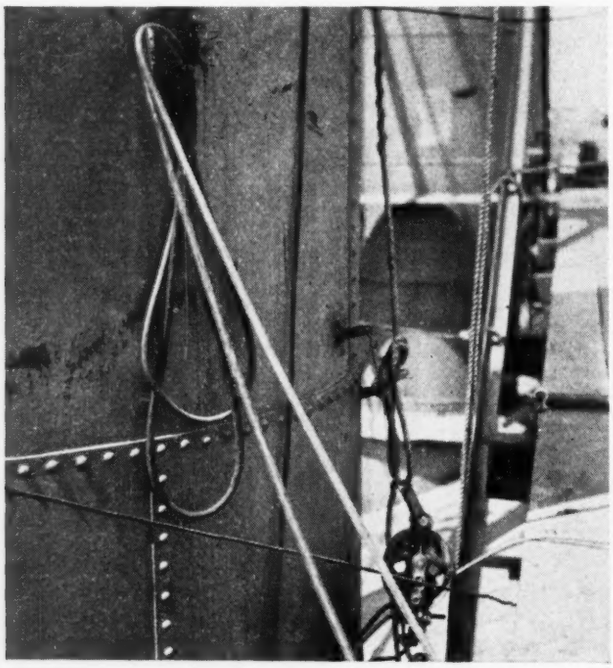


7—"A" frames at top of temporary shoring were used in placing new welded sections. Tandem platform inside stack provided two working levels, upper for tacking sections in place, lower for simultaneous finish welding

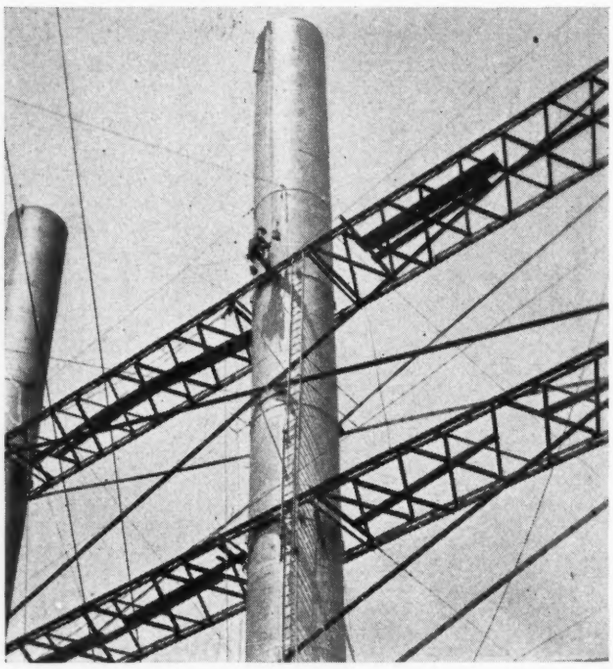
9—Butt joint between sections was completely filled with weld metal leaving a flush surface. Outside bottom of butt strap was not welded



10—Dismantling last of seven stacks. All but the last section of the next stack at left has been completed. Note some of 28 other smaller stacks of the Alameda plant in foreground



8—Field methods possible with free use of cutting and welding include "pass" holes for welding cables and sandblast hose, temporary attachment of sheave blocks, snub lines and guys



11—New sections were sandblasted inside and out and received first coat of stack paint in the shop. Here painter applies finish coat by hand from a "bos'n's" chair

THE OLD CHIEF

III—Random Reminiscences

Third in a series by William Doran, chief engineer, Essex County Sanatorium, Windsor, Ontario. Writing of the inspiration of the past, he has captured much of the human side of engineering that lies beneath the maze of power-plant costs and the waving lines on paper disks

▶ IT WAS NO EASY MATTER to start the Old Chief off in a reminiscent mood. The time and the place had to be propitious, but once started he was a mine of interesting stories. I remember one time after the Old Chief had been running a hydrostatic test, he told me about a test he had helped to make on the high-pressure line of an admiralty job.

During the test a high-ranking Board of Trade inspector came along until he reached the end of the line where a crusty old engine fitter was standing guard at the gage. "What pressure have you there, my man?", asked the inspector.

"None", replied the crusty one.

"Let me see", said the inspector. "Are you sure that the pointer has not made a complete circle around the dial?"

The old fitter drew himself up to the height of his Celtic dignity and replied very emphatically, "I am very certain, Sir, that it has not gone around forward, and it has not gone around backward, and I'll be ** !! ** if it has gone around sideways."

It was afterwards discovered that an apprentice had failed to cut out the center of a flange gasket. When it was finally located and removed, the gasket was found to bear a striking resemblance to a ten-gallon hat.

A Born Teacher

There were no vocational schools in those days to take the rough edges off the raw men coming into the game. Usually firemen and coal trimmers were selected for their brawn and promoted on their mechanical ability and reliability. The Old Chief was a born teacher and quite early in our association he broke down my fear of big words. His method was to break them down and build them up. For instance, we had an air compressor in the plant, and he soon made the words adiabatic and isothermal as much a part of my vocational vocabulary as stymied and vulnerable were of my recreational vocabulary.

How to Use a File

I have him to thank for showing me how to use a file without rocking, how to use a chipping hammer with either hand, and always with the thumb and forefinger loose, how to braze and solder, how to lay out and fashion sheet-metal work. Welding was frowned on in those days as an unreliable makeshift. This was perhaps due to the fact that there were so many incompetent welders in the game at that time. Today welding has become almost indispensable to the repair man.

One lunch time the Old Chief exhibited a Stillson wrench he had just fished out of a heat exchanger as it was about to be closed up, so the talk turned to the various articles that the speakers had found in closed vessels. These ranged from everything you could find in a hardware store to the bones of a jaguar. The stories were getting taller and taller until the Old Chief, with a perfectly straight face, told of a friend of his in the Eastern trade who, on opening up a clean-out screen, pulled forth a sofa and six plush chairs.

The timekeeper on that job was an old Irishman who had been permanently lamed through an accident suffered during the building of the plant many years before. He had a true Irishman's wit. One day he phoned the Old Chief. "Listen, Chief", he said. "There are two Englishmen, a Dutchman, a colored man and one white man here waiting to see you about that job."

"What nationality is this 'white man'?", asked the Chief.

"An Irishman, of course," answered the timekeeper. "I thought you would know."

There was one day every year when the boiler room was house-cleaned and painted up—that was on the occasion of the annual July shareholders' meeting. The "gentle folk" would promenade through the boiler room and take turns looking into the furnace through blue glasses.

Up in the engine room it was usual to entertain the visitors by balancing

"Two Englishmen, a Dutchman, a colored man and one white man waiting to see the Chief about that job"

coins on various parts of the engine to show how steady it was, or by dimming the lights and making static electricity jump from our fingers to the big belt, or, of course, by giving them all the statistics on coal, steam horsepower, etc.

I remember one frail old lady, the wife of one of our most influential shareholders. She would never fail to visit the power plant and before leaving would present each of the men with a neat bundle of religious tracts. At the same time, in another corner, her husband would be telling the firemen risqué stories and giving them "sure-fire" tips on the ponies.

Another annual visitor was a big name in national political circles who would unfailingly tell us how as a boy he fired his father's portable sawmill and how it blew up one day and cured him of boilers for life. He would go into details and repeat the story every year.

Following the shareholders' meeting, the paint brushes and the mops would be placed away for a long rest, the windows would cloud up again and the boiler room would resume its normally healthy and respectable coating of coal dust and flyash.

New Pumps Cut Power Costs in Half

Three modern 78,750-gpm propeller pumps driven by 600-hp motors replace three old units for dry-dock service, cut power cost 47% and pumping time 23%. Operating experience reported by R V Terry, hydraulic engineer, Newport News Dry Dock & Shipbuilding Co

Fig. 1—Thrust bearings for the pumps are supported in steel-girder structures similar to those on a hydroelectric generator

▶ DRY DOCKS that will take a modern ocean liner or a battleship hold large volumes of water and require large-capacity pumps to empty them in a reasonable time. Capacities of the three dry docks of the Newport News Dry Dock & Shipbuilding Co range from 9,000,000 to 22,000,000 gal with static heads of 26.2 to 34.5 ft. When a ship is in the dock it displaces part of this water, but there is enough left to require a lot of pumping.

When these docks were built in 1900 and 1905 three large vertical-shaft pumps were installed to empty them. These pumps were single-suction volute type with 60-in. suction and discharge and radial-flow impellers. Each was driven by a 900-hp ac motor, the speed of which could be adjusted from about 120 rpm at the beginning of the pumping period to 90 rpm at the end. Two pumps, with selective suction by butterfly valves, served one of the smaller and the large dock while the third dock was served by one pump.

These units could be operated faster, and thus empty the docks more quickly, at the beginning of pumping because of the low head. This gave a greater discharge without overloading the motors and without overloading the old steam-engine-driven generators which supplied the current. As the dock was emptied the head and torque became greater. Then, the pumps were slowed down due to the limited power available. From the standpoint of efficiency, it would have been better to operate such pumps slowly at the low head and speed up as the head increased. However, time and available power for pumping, rather than efficiency, were the primary considerations.

These pumps gave good service for nearly 35 years, but their efficiency was only about 58.5% when tested in 1901 and had dropped to about 50% when tested in 1937. They were also in poor condition and rather than repair them we decided to install new ones of modern design. We built several 10-in. models and tested them in our hydraulic laboratory. From studies made of these models a design was selected best suited to the job and interchangeable with the old pumps.

Propeller-Type Pumps

The new design has a single-suction, cast-steel, 6-blade propeller-type impeller, Fig. 2, in a cast-iron volute casing, Fig. 3. The new pumps have a suction-eye diameter of 56 in., Fig. 4, compared to 10 in. for the model. They discharge 175 cfs (78,750 gpm) at best efficiency against an intermediate head of 25 ft. Their rated specific speed at best efficiency is about 5000 and they are driven by 600-hp, 200-rpm General Electric synchronous motors.

We built, installed and tested the new pumps in 1937; performance of one of them compared with that of the model is shown in Fig. 5. Maximum efficiency of 91% was obtained on the 56-in. pump at 200 rpm compared to 84% for the 10-in. model tested at 1120 rpm. Test efficiency is somewhat higher than we expected from stepping up the model efficiency by the well known Moody formula, used for hydraulic turbines. The prototype efficiency computed by that formula would be 89.6%.

Compared with the old pumps, the new ones show a saving of 47% in power required to pump a dock, 23% in time and a substantial saving in monthly demand charge for power. We found that the new pumps used 1800 kwhr to pump the largest dock, without a ship, and the old pumps required 3400.

Discharge from the new pumps is slightly less than that of the old ones at the beginning of the pumping period. Near the end of the pumping period, heads of the new pumps hold up better than on the old and they deliver about 2.5 times as much water as did the old ones at corresponding head. This reduces the total pumping time 23%. Dry-dock pumps operate at an unusually low load factor, each dock being pumped out about 75 times per year. But in spite of the low-use factor of the pumps the estimated power saving will be 180,000 kwhr per year.

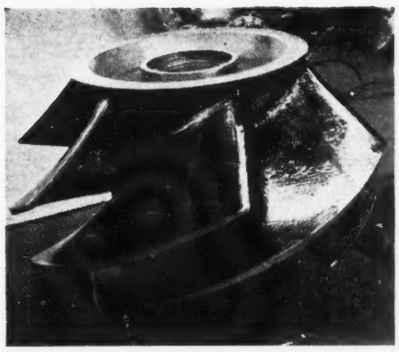


Fig. 2—Cast-steel propeller-type runner for one of the new pumps

The pump models were tested with and without suction baffles to smooth out the flow to the pump. Two pumps serving docks No. 1 and 2 were built with vertical baffles in the suction, as in Fig. 4. These baffles increase the head near shutoff to take care of possible extreme head conditions due to high tides caused by winds. From the model tests we found that the baffles increased the shutoff head about 5 ft. The difference in head with and without baffles in the suction disappears at about 110 cfs (50,000 gpm) discharge. The reason for the increased head is that without baffles at low discharge, near shut-off, the impeller makes the water rotate in the suction pipe. This causes what we term "prewhirl", whirl in the direction of rotation, which reduces effective head of the pump. The baffles prevent or reduce rotation in the suction pipe and cause the impeller to develop a higher head.

Power Required

Fig. 5 shows that the power to drive this type of pump is fairly constant over a wide range of load. For example, between 80 and 230 cfs discharge, the power remains between 500 and 550 hp. Maximum power required during test was about 550 hp compared to the motor rating of 600 hp. With suction baffles, power required at shutoff would be about 660 hp. The pumps, however, will never operate under these conditions, as they have no discharge valves other than a swing check at the discharge end of the pipeline, located at mean high-water level.

The new higher-speed ac motors are much smaller than the old dc units and are installed between and supported by the large cast-iron girders that supported the old motors. All three pumps are of identical design except for the suction baffles previously mentioned, on two of them. Two of the pumps however, rotate clockwise, when viewed from the top, and one runs counter-clockwise. This was done so that they fit into the old 60-in. discharge piping, which was not disturbed.

When using a constant-speed ac motor for dry-dock pumping service a relatively steep head-discharge curve is required to obtain a reasonably high discharge at the higher heads. Characteristics of the propeller-type pumps selected are especially suited to this service. A pump of moderate specific speed was selected for reliability and to be free of cavitation and pitting. The model was carefully tested for cavitation. In operation the pumps are very quiet and free of vibration over their entire range, thus indicating freedom from cavitation. The range of operation on dock No. 2 is ordinarily from a discharge of 275 cfs at 5-ft dynamic

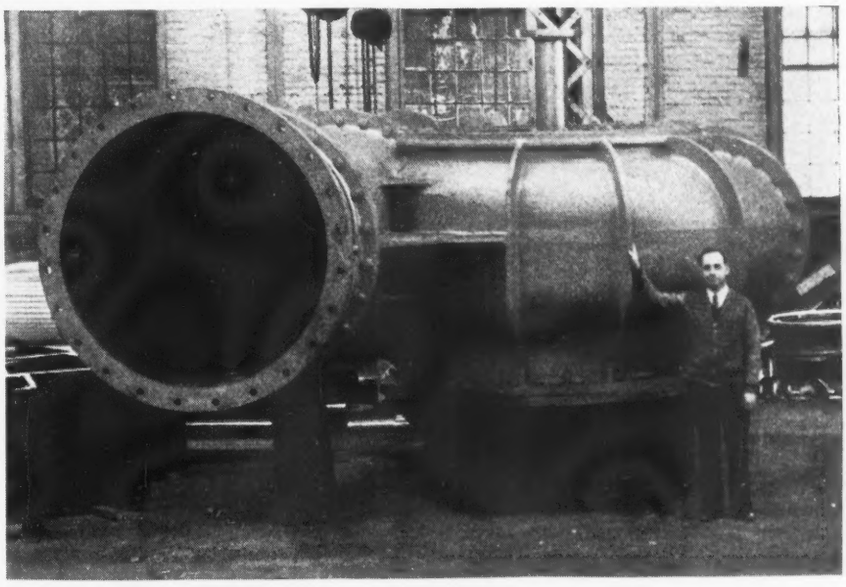


Fig. 3—Cast-iron volute casing has 56-in. suction and 54.5-in. discharge

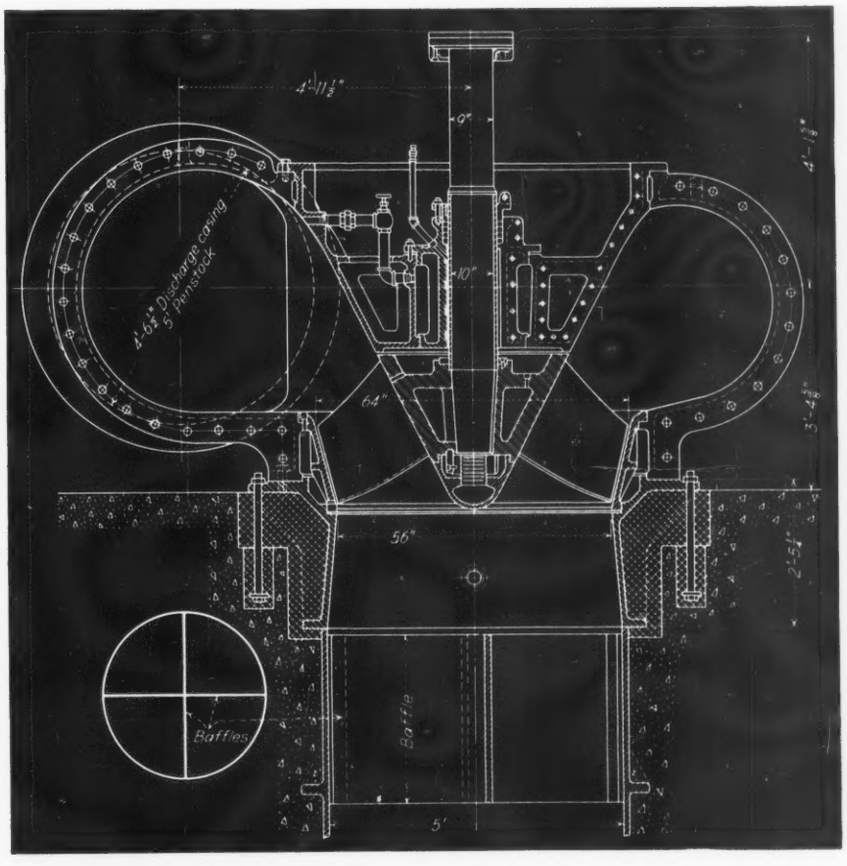


Fig. 4—Cross-section through one of the pumps shows the baffles in the suction

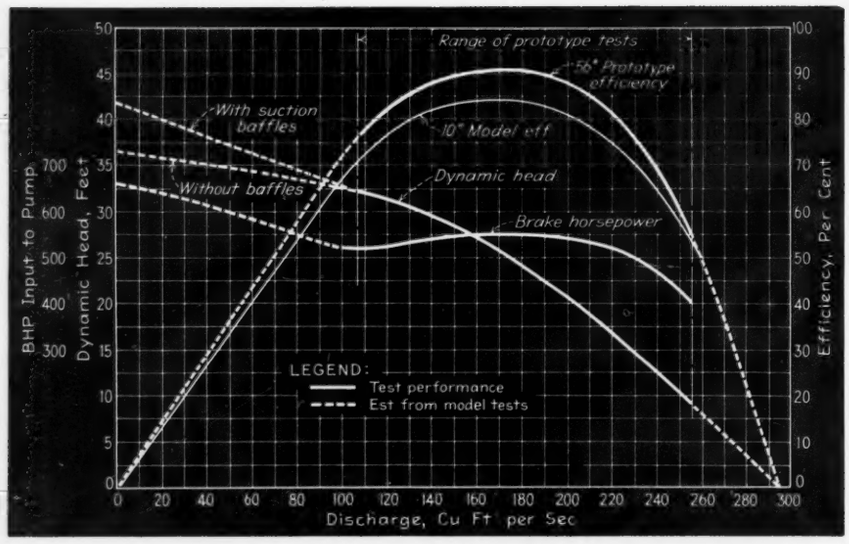


Fig. 5—Test performance curves of a 10-in. model and a 56-in. propeller pump

head (zero static head with dock at level of the James River) to a discharge of about 100 cfs at 35-ft dynamic head.

We feel that the prototype test results shown in Fig. 5 are quite accurate as the water was measured volumetrically. Dock-level readings were taken against time and the discharge computed from an accurate curve of dock capacity versus elevation. The horsepower input to the pump was computed from the input to the motors, measured by test instruments, using the manufacturer's shop test curve for the motor. The suction and discharge piping being of the same diameter (60 in.) the dynamic head was measured directly by a U-tube manometer connected to the suction and discharge piping by manifolds, each with four equally spaced piezometer taps. At the time of test specific gravity of the water was 1.008, but may go up to about 1.020, depending upon tidal conditions.

Each pump is provided with one grease-lubricated babbitted bearing in the crown plate, which is jacketed and cooled by water from the pump casing. The thrust bearing is above the motor, the same as in a vertical hydroelectric generator, Fig. 1.

The complete cost of the new installation of three pumps, motors, and controllers was about $65,300.

In each of the two pump houses there is also a 20-in. drainage or stripping pump of the vertical, single-suction, centrifugal type driven by a 150-hp, 580-rpm induction motor. These pumps are each designed for a capacity of 11,000 gpm at 37-ft head. When emptying the suction tunnel under the main pumps for inspection they must operate against a maximum head of 46 ft. The shut-off head of these pumps is about 57.5 ft. The high-head shipwashwater and emergency fire pump was described in November POWER, page 76.

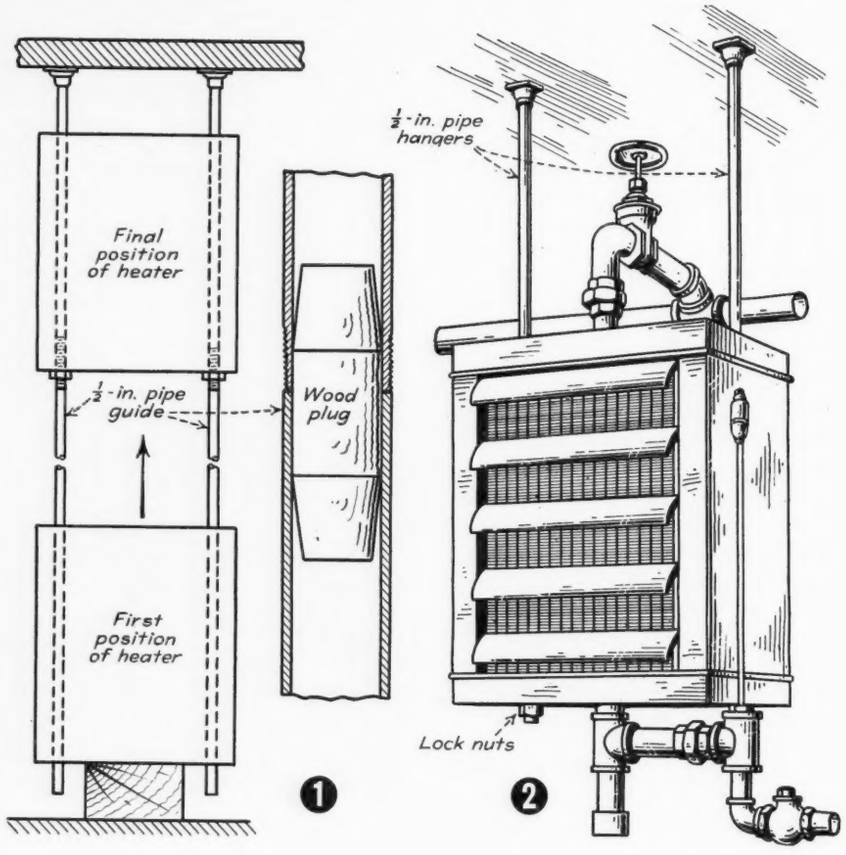
Guides Make Job of Hanging Unit Heaters Easy

DID YOU EVER TRY to balance a unit heater in the air and mount it on its hangers? I have, and found it to be a tough job, so decided to do something about it. After the hangers were properly located on the ceiling, I cut two pieces of pipe, the same size as the hangers, reaching from the hangers to within about 6 or 8 in. of the floor.

These pipes acted as guides when the heater was lifted into place. A slightly tapered wooden plug was put into the top end of each guide pipe, the heater placed on a box and the guide pipes put into the hanger holes in the heater. The heater was then located directly under the hangers and the wooden plugs of the guides inserted into the ends of the hangers, see Fig. 1.

When all was ready, we raised the heater up onto the hangers, the guide pipes acting as a track to insure that the heater would go into place easily. We then removed one guide at a time and put the nuts onto the lower end of the hangers and the job was finished, Fig. 2. No block and tackle was required and two men easily lifted the heater into place.

Englewood, N. J. R BOTTINGER



Automatic Combustion Control Fires Four Fuels

Two boilers, equipped with automatic combustion control, burn coal, pitch, tar or oil at monthly efficiencies of between 81 and 86%, depending upon kind of fuel

Fig. 1—Meters and control on the panel board permit operation of the boilers under practical test conditions at all times

▶ AT THE Haverstraw Industrial Terminal, Garnerville, N. Y., two new Kennedy-Van Saun boilers have been installed and a third is now going in. One of these units is rated 90,000 lb of steam per hour and is equipped to burn coal, pitch, oil or tar. The other boiler, generating 65,000 lb of steam per hr, burns either oil or tar. The kind of fuel used is the one which will produce steam at the lowest cost.

To insure that anticipated economy would be obtained with any fuel selected, W F Larkin, president, and George W Concklin, plant engineer, equipped the boilers with automatic combustion control and meters so that they can be operated under practical test conditions at all times. The meters and the Hays Corp automatic combustion-control equipment are arranged on a central panel board where plant performance is continually under observation of an operator. It is easy for the operator to make any necessary adjustments and then check to see that the desired results have been obtained.

The Meter Set-up

On the meter and control panel are integrating and recording steam flowmeters for each boiler. One of these meters also records feedwater temperature. On the large boiler a CO_2 recorder also records inlet and outlet gas temperature of the air heater. A 5-point indicating draft gage is connected to indicate furnace pressure, forced draft at the burners, draft in the last pass of the boiler, air-heater outlet draft and mill suction pressure.

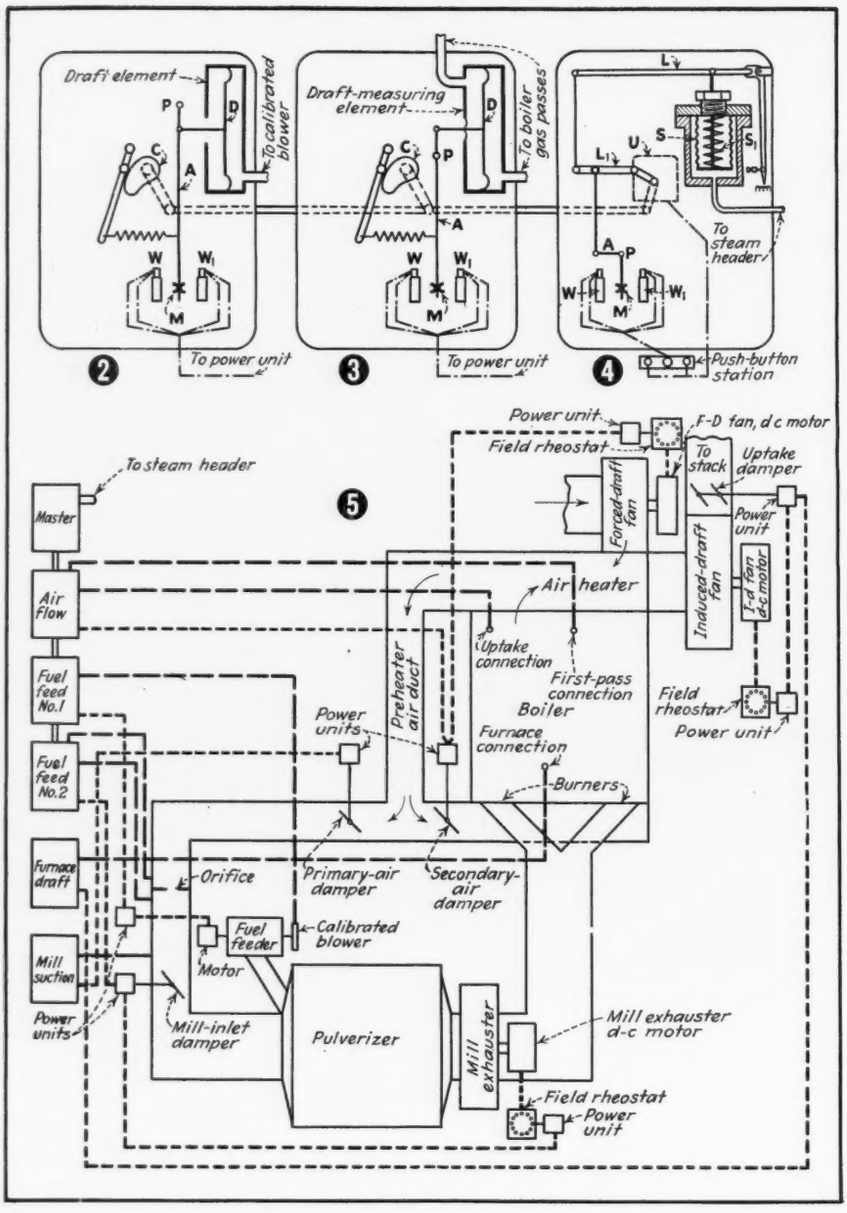
On the small boiler a CO_2 meter records the flue-gas temperature at the boiler exit only, as this boiler does not have an air heater. A 2-point draft gage indicates draft in the furnace and at the boiler outlet. Other meters on the panel board indicate steam-header pressure and electric load on the power plant.

The large boiler's automatic combustion-control equipment on the panel board includes a master controller actuated by steam-header pressure. This master in turn actuates an air-flow and two fuel-feed controllers that meter air and fuel flow to the furnace for maximum combustion efficiency. A furnace-draft and a mill-suction controller maintain constant pressure in furnace and mill suction. Indicators on air-flow and fuel-feed controllers show the boiler loading and division of loading between units when more than one are in operation. A switch on each controller permits changing from automatic to manual pushbutton control or vice versa.

Because the smaller boiler burns oil or tar only, was installed to carry base loads and does not have an air heater, it is equipped with fuel-feed and air-flow and furnace-draft controllers only. The fuel-feed and furnace-draft controllers are on the panel board and the air-flow control at the boiler front.

In the master regulator, Fig. 4, header pressure outside the sylphon S is balanced against the loading spring S_1. Bottom of the sylphon connects to lever L which connects to floating lever L_1. Angle A, pivoted at P, has its left-hand end connected to L_1 and carries on its lower end two small permanent magnets M, between mercury switches W and W_1. A power unit U on the back of the master has two cranks on its shaft, one of which connects to lever L_1 and the other to one end of the mechanical connection to the air-flow and fuel-feed controllers.

If the steam pressure drops 0.1 lb the sylphon will elongate and the left-hand end of levers L and L_1 will move downward. This movement will swing the magnets to the right and close switch W_1 to energize power unit U. This unit will turn in a clockwise direction and lift the right-hand end of lever L_1 to bring the magnets to neutral position.



Figs. 2, 3 and 4—Fuel-feed, air-flow and master controllers, respectively. Fig. 5—Diagram of combustion-control system for firing pulverized fuel

Then switch W_1 opens and stops the power unit when the air-flow and fuel-feed have been set for a definite increase in the combustion rate as indicated by the decrease in steam pressure.

The air-flow controller, Fig. 3, includes a draft-measuring element connected across the boiler. Cam *C*, so shaped that it eliminates the square-root factor between differential draft and rate of air flow, connects to the master motor operator, as previously explained. Arm *A*, pivoted at *P*, connects to diaphragm *D* and carries permanent magnets *M* at its lower end. On either side of magnets *M* are mercury switches *W* and W_1 which close if the magnet moves toward them.

The fuel-feed control, Fig. 2, is similar to the air-flow except in the method of compensation, which is by a simple draft element with a slack-leather diaphragm *D* connected to a calibrated blower (small fan) driven by the fuel feeder.

If steam pressure starts to drop, indicating a demand for more heat, the master regulator functions and slightly turns the cams clockwise on the air-flow and fuel-feed controllers. This action moves the permanent magnets toward the left-hand switch on each controller and it closes. Closing of these switches energizes the necessary controls to increase the air flow and fuel feed to the boiler. Increased air flow through the boiler increases the differential across it. This increase in differential pressure acting on diaphragm *D* of the air-flow controller moves its arm to the right to the neutral position where it stops after air-flow has been adjusted according to demand indicated to the master by steam-pressure decrease.

When the fuel-feeder increases speed, suction of the calibrated blower increases on the right-hand side of diaphragm *D* on the fuel-feed controller. The controller arm then moves to the right and opens the mercury switch when the fuel feed has been correctly adjusted. An increase in steam pressure has opposite effects to those just described to slow down the combustion process.

The furnace-draft and mill-suction pressure regulators are similar to the fuel-feed controller, Fig. 2, except that the master cam is omitted and arm *A* is held in its neutral position by balancing furnace pressure or mill suction against tension of a spiral spring.

Fig. 5 is a diagramatic layout of the larger boiler, pulverizer and combustion-control equipment, when burning solid fuel. This boiler is equipped with an air heater, forced- and induced-draft fans. Draft fans and mill exhauster are driven by direct-current motors, the speeds of which are regulated by field rheostats. These rheostats have 45 control points, therefore adjust motor speed in small steps giving close regulation of air flow. Suitable dampers also operate in conjunction with changes in fan speed. Adjustment of the combustion equipment is made by electric power units actuated by the controllers on the panel board.

How Control Operates

To get a general idea of how the combustion control operates, assume in Fig. 5 that steam pressure drops slightly. This causes the master to make an adjustment of the air-flow and fuel-feed controllers for a definite increase in air and fuel to the furnace, as indicated by the change in the steam pressure. The air-flow controller energizes the power unit to open the secondary draft fan. If the demand for increased air is not satisfied when the damper moves through a small arc, a contact closes to start the forced-draft-fan power unit to increase the speed of the fan. When the air flow has been correctly adjusted, increased differential pressure across the boiler again puts the controller in neutral.

Simultaneously with the air-flow adjustment, No. 2 fuel-feed controller energizes the power unit on the mill-inlet damper to start opening this damper. If moving this damper through a small arc does not satisfy the demand for more fuel from the mill, a contact closes to increase the mill-exhauster-motor speed by field-rheostat adjustment. In-

creasing the air flow through the mill steps up the differential across the orifice in the primary-air duct to return No. 2 fuel feeder to neutral.

Changing the position of the mill-inlet damper causes a decrease of pressure back of it. This change of pressure upsets the mill-suction-controller balance and it closes contacts to energize the primary-air-damper power unit. When this damper opens sufficiently to restore the pressure back of the mill-inlet damper, the mill-suction controller returns to neutral.

All this has upset the furnace pressure but the furnace-draft regulator has been following along to hold this pressure constant by adjusting the stack damper and the induced-fan-motor speed.

Along with the other adjustments, fuel-feed controller No. 1 has been increasing the rate of coal flow to the pulverizer by speeding up the coal feeder. When the feeder reaches a speed corresponding to the increased load demand, as established by the master, suction pressure of the feeder calibrated blower is sufficient to return No. 1 controller to neutral.

All these adjustments occur practically together so that fuel-feed and air-flow change simultaneously. The two increase or decrease in metered quantities to provide the heat necessary to meet steam demands with only slight changes in steam pressure.

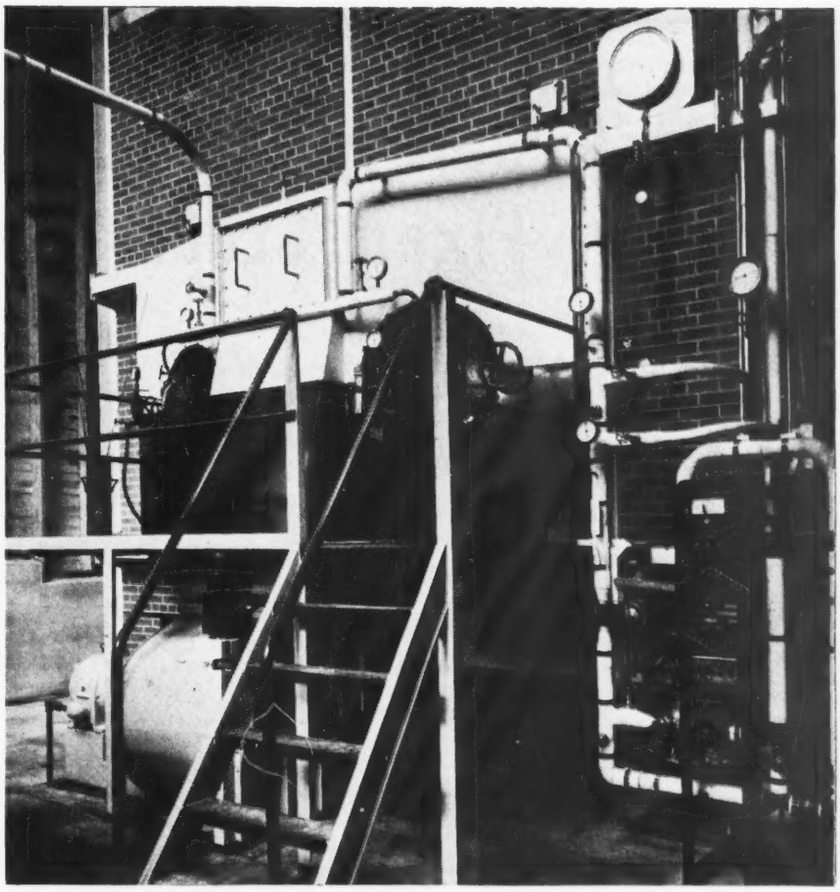


Fig. 6—Small boiler burns either oil or tar, has forced-draft fan under the two burners, air- and fuel-control at right

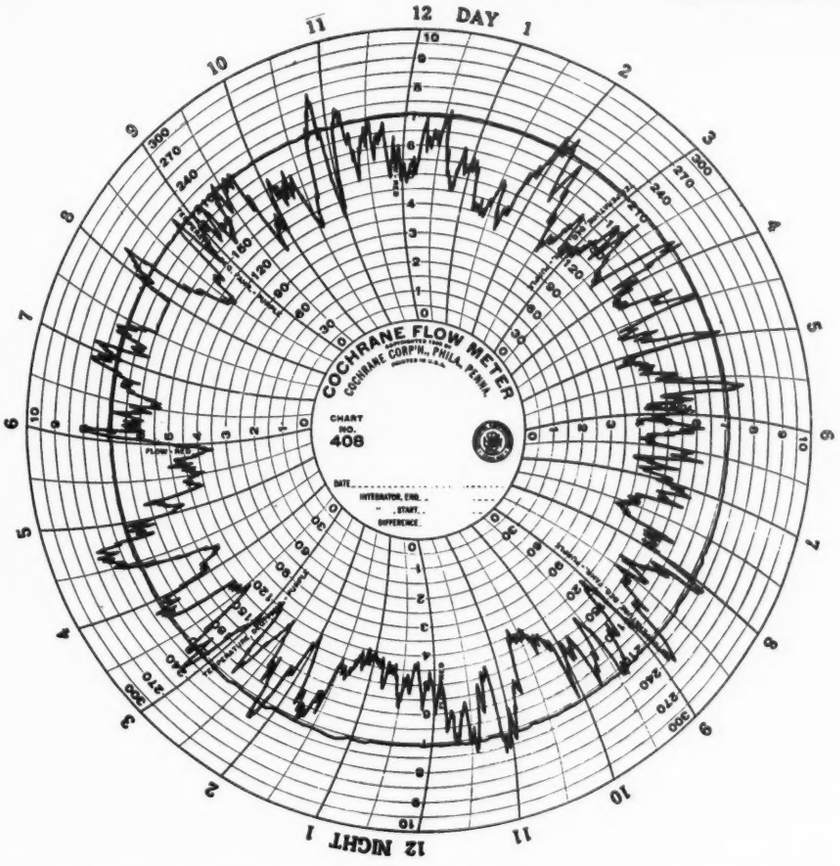


Fig. 7—Steam flow ranges from 35,000 to 85,000 lb per hr; feedwater temperature is about 212 F

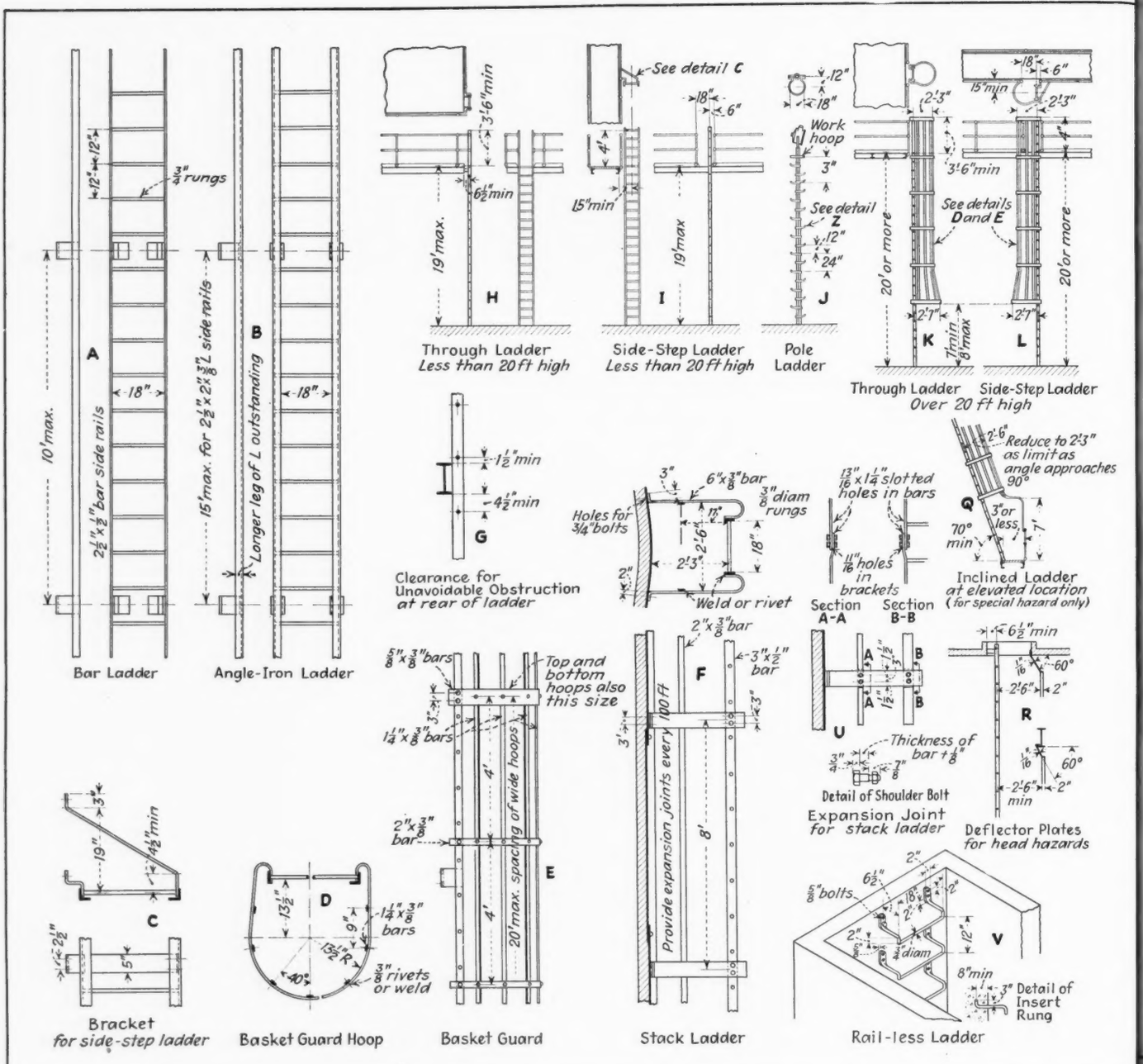
Fuel-feed, air-flow and furnace-draft controllers are compensated for capacity lag of the boiler and inertia so that there is no hunting. The controllers make a definite change in rate of air flow and fuel feed for each slight change in steam pressure, as indicated by the position of the master.

When burning liquid fuel, the master, air-flow, fuel-feed No. 1 and furnace-draft controllers only are used. Switches are provided so that the change from one fuel to another can be made without interfering with operation.

The load on the boiler fluctuates through wide ranges with sharp peaks of 60,000-lb-per-hr change in five minutes. When operating under these conditions, steam pressure and CO_2 are held practically constant. When burning tar, the average boiler and furnace efficiency is 86%; with oil, efficiency is 85%; and with pitch it drops to 81% because cold primary air must be used on account of the low melting point of the fuel. This lower efficiency is taken into account when comparing fuel costs.

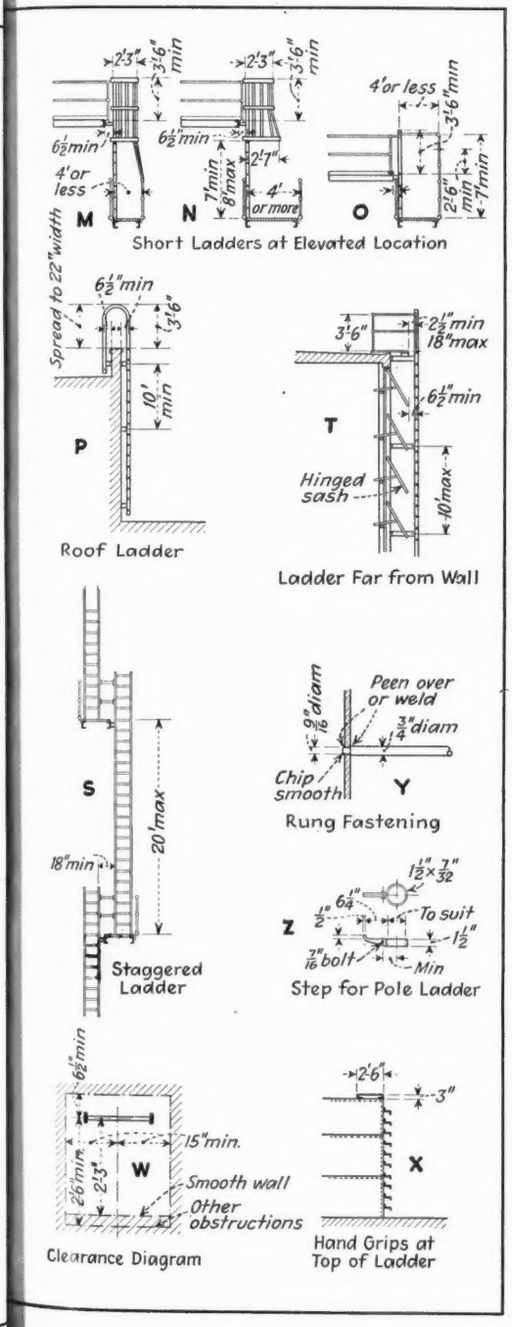
Safety Standards for Fixed Steel Ladders

W Elwood Rossnagel, safety engineer, Consolidated Edison Co of New York, draws on a wealth of experience to set down simple rules for ladders. Drawings of construction details show how maximum safety and convenience are attained by following these standardized details


Bar Ladder
Angle-Iron Ladder
Through Ladder Less than 20 ft high
Side-Step Ladder Less than 20 ft high
Pole Ladder
Through Ladder Side-Step Ladder Over 20 ft high
Clearance for Unavoidable Obstruction at rear of ladder
Inclined Ladder at elevated location (for special hazard only)
Bracket for side-step ladder
Basket Guard Hoop
Basket Guard
Stack Ladder
Detail of Shoulder Bolt
Expansion Joint for stack ladder
Deflector Plates for head hazards
Rail-less Ladder
Detail of Insert Rung

▶ REALIZING THE GREAT NEED for standardization of wood ladders, particularly from a safety viewpoint, the American Standards Association has published the "Safety Code for the Construction, Care and Use of Ladders," now universally adopted. This code also covers briefly the design of fixed steel ladders, but supplementary details given here aid in designing for many common problems.

These data have been adopted by many users of steel ladders to assist designing engineers and draftsmen in making all ladder installations as safe as practicable and to promote uniformity of construction. Fig. 1 shows typical details of ladders; the various details are referred to in the text by letter symbols.



Perhaps the most important rule is the one designating proper climbing clearances for a man on a ladder. The distance from rungs to the nearest obstruction behind a man should be not less than 30 in. unless it is a smooth wall or other surface extending upward from the floor of the lower landing, in which case a distance of 27 in. is permitted. Sidewise clearance from the centerline of the ladder should be not less than 15 in. either side. Toe room behind the ladder rung, see sketch W, should be at least 6½ in.

Occasionally a beam or brace may be unavoidably close *behind* a ladder. Rules permit this if within limits shown in *G*. Where obstructions less than 30 in. from the front of the ladder cannot be avoided, the head hazard can be reduced by installing a deflector plane, *R*, to push the head gently away from the obstruction. A smooth steel plate, of suitable gage and at least 24 in. wide, should be secured so that it makes an angle of not less than 60 deg. to the horizontal and should have its rolled or bent-back lower edge not less than 30 in. from the ladder.

Ladders, Not Stairs

Vertical ladders are preferred to inclined ladders for use by experienced men. For fire escapes and the like, for occasional or emergency use by unaccustomed persons, the inclined ladder is undoubtedly safer. Under no condition should a ladder be placed at an angle less than 70 deg.

Ladders should be 18 in. from inside to inside of side rails as shown in *A* and *B*. If angle rails are used, they should be placed as in *C* in order to afford proper grip for the hands when climbing. Side rails or stringers should be of adequate strength, not less than 2½ x ½-in. bar or its equivalent, and they should be supported at frequent intervals, preferably not more than 10 ft. Rungs should be ¾- or ⅞-in. diameter with tenons ⅛-in. smaller. After inserting into the side rails, tenons should be peened over or welded in place, see sketch *Y*. Butt welding of rungs without tenons to the side rails should not be permitted.

Rungs should be evenly spaced and about 12 in. apart unless local conditions prevent. In order that a rung may come at the same elevation as the surface of the upper landing platform, spacing may vary somewhat from 12 in. In very short ladders, maximum spacing should not exceed 15 in.

So-called "ship ladders" are potential causes of accidents. These are steep inclined ladders usually provided with double rungs or with treads and handrails. They offer an invitation to descend facing forward with the ever-present danger of catching a heel on a rung or a foot slipping off a tread due to the calf of the leg striking the rung above and preventing proper foothold.

That First Step

In general, there are two ways of getting on to the upper end of a fixed ladder, either by stepping sideways or by stepping through the ladder. "Side-step" ladders are preferred to the "through" type as it is considered safer to step sideways where the ladder is in full view than to step blindly backwards through the upper end of a ladder. Sketch *I* shows a typical arrangement of side-step and *H* illustrates a through ladder. The upper end of a side-step ladder should include four rungs above the last one used for stepping. Omission of these rungs leaves a wide-open space in front of a man and requires a change of grip from rungs to side rails in climbing.

Where required to reach a height of over 40 ft. by ladders, individual sections should be limited to 20 ft. and properly railed landings provided as shown in *S*.

Need for basket guards, *K* and *L*, depends on the length of ladder and some difference of opinion exists as to maximum safe length without guard. On very long ladders, such as on chimneys, where a man must stop frequently to rest, there is no question as to the need for protection. On short ladders guards are obviously not required. An arbitrary length limit must be chosen as maximum without basket guard. Safety engineers suggest that such a cage be used on all ladders longer than 20 ft. between landing levels.

Sketch *D* shows arrangement of a basket guard for a ladder with either bar or angle side rails. Sketch *E* shows the vertical spacing of hoops. To avoid a head hazard when entering the basket guard, the first hoop is made larger, sketch *N*. Other possibilities are the extension of rear bars of the cage, *M*, or for certain elevated

Fig. 1—Standardized details for ladder construction not only provide safety at reasonable cost, they also reduce labor of investigating hazards and clearances. Sketches here show usual ways of making ladders convenient so that each new installation needs less invention

locations, a high reinforced handrail, sketch *O*.

In special locations such as coal-unloading towers or tipples, inclined ladders extend high up the structure and protection is required. For these the depth of the basket guard should be increased from 27 in. to 30 in. to make climbing as easy as possible, see sketch *Q*.

Particular attention should be paid to the handrail construction at the head of a ladder. At "through" ladders, the railing on the upper platform should be extended and bolted to the extension of the side rails as in *H*. At side-step ladders, an opening 24 in. wide should be left in the handrail 18 in. to the front of, and 6 in. to the rear of the plane of the ladder as in *I*. The toe plate on the edge of the upper platform should be omitted directly in front of the ladder well.

Chains are not recommended for protection at ladder wells because they will not be used by the average workman. A self-closing gate, hinged on to the plaform, is sometimes employed, but even this presents some hazard to a man stepping off the ladder as it diverts his attention from his normal movements.

Staggered Railing

The most satisfactory protection for the approach to the upper end of a ladder is by means of a staggered railing. Unfortunately, the latter requires considerable floor space, often not available. A staggered railing is a standard railing, without toe plate, in the form of an "L" or "U" so placed as to make it impossible for a person to walk accidentally into an open ladder well. When properly designed, Fig. 2, a barricade is presented which requires intentional progress along a crooked path to reach the ladder.

For access to the roof of a penthouse, a "gooseneck" ladder, *P*, is generally used. At the top of "through" ladders of any type, the space between the top rung and the edge of the flooring or coping should not exceed 18 in., *T*, or be less than 2½ in. to allow finger room.

In subsurface manholes, tanks, and on brick chimneys, a railless or "U"-type ladder rung is common. The rungs in these cases are usually bolted to the wall, but in some instances are cast or set into the masonry. Such rungs should be formed with a 2-in. extra bend at the ends of the climbing portion to prevent a man's foot from slipping off the end of the rung, sketch *V*.

Where it is not possible to extend the handrails above the top of a tank or a roof, handgrips should be provided on the upper surface to facilitate getting off and on the ladder. One type is illustrated in sketch *X*.

Although not recommended where standard ladders are possible, the pole ladder shown in sketch *J* serves a useful purpose. Primarily for floodlight poles, the steps are formed by placing a number of bent steel straps, *Z*, on the pole alternately. At the top of such a ladder, an 18-in. diameter hoop, see sketch *J*, allows a man to stand inside it comfortably and have both hands free to work.

Hatch covers over ladder wells should be as light in weight as possible, consistent with the loads which may be placed on them. Heavy covers may be counterweighted to stay in either closed or open position. If not counterweighted, the cover should open at least 15 deg. beyond vertical or be provided with a self-engaging latch.

If practicable, hatch covers may be arranged with their hinges behind the ladder, that is, in view of the man. The

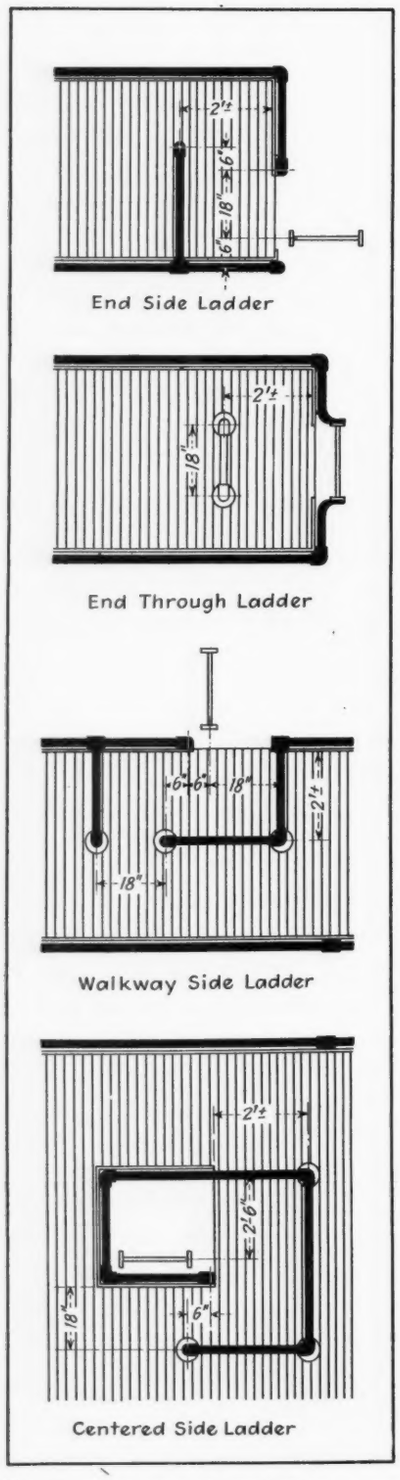


Fig. 2—Four ways of reminding a man he is about to climb down a ladder

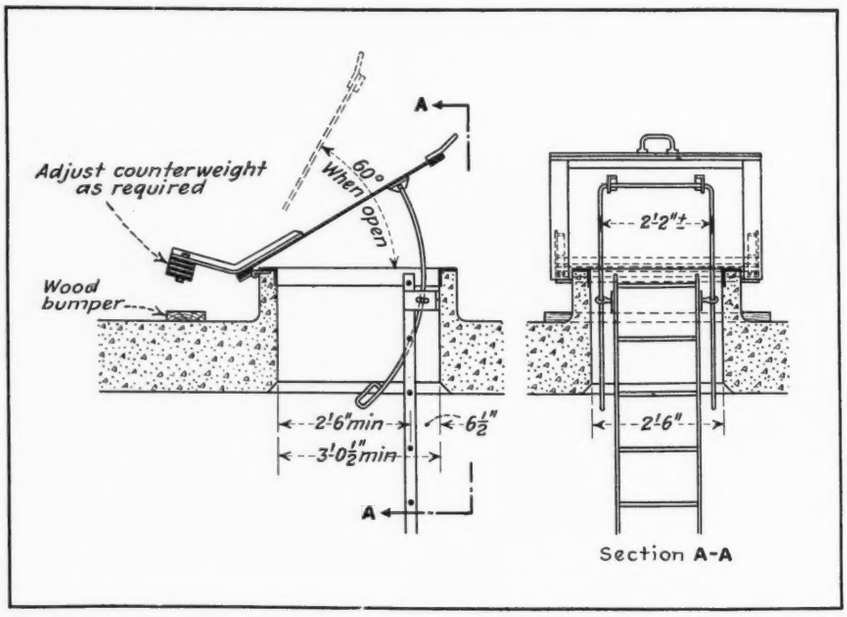


Fig. 3—Even a roof opening can be made reasonably safe by a pair of bent-bar handles for the hatch

covers should then open 90 deg. and be secured, and may be provided with several "U"-type rungs, *V*, so placed as to act as a continuation of the ladder when the hatch is open.

At a roof hatch where a staggered railing would not ordinarily be provided, the hinged cover should be provided with steel rods bent into the form of bows, Fig. 3, to offer some protection when the cover is in the open position.

Safe Landings

Bases of ladders mounted on platforms should be within the area of the flooring and not mounted on the outer side of the toe plate, as this latter condition presents poor footing on the platform under the bottom rung of the ladder. Where it is not obvious which side of the ladder a man should climb, the improper side should be obstructed by a warning sign or some other device. All ladder landings should have flooring, handrails, toe plates and other details of standard design.

The type ladder shown in sketch *F* forms its own basket within which a man climbs and is recommended for steel stacks. Like all ladders on tall stacks, it should be designed with a sufficient number of expansion joints, *U*, as the ladder temperature does not change with stack temperature. Vertical bars at the sides of the ladder are located to give adequate protection against a man falling or being blown off the ladder in a high wind, yet permit him to squeeze past them to reach a scaffold if necessary. A seat can be provided every 50 ft or so by offsetting one of the bars outward. Here a man can rest or get out of the way while another man passes him.

Many brick chimneys and steel stacks are not equipped with basket guards or other safety devices. Where protection is desired without excessive cost, a ⅜-in., 7-wire strand of galvanized steel or other non-corrosive metal can be stretched up each side of the ladder for its entire length. Every 30 ft. (15 ft. staggered) each strand is passed through an eyebolt or is otherwise secured to the ladder, and a strain is taken on the strands by turnbuckles.

A man, climbing the stack ladder, wears a 3-in., 4-ply cotton-webbing body belt with forged-steel (not malleable) snap hooks on short chains on each side. These hooks, attached to the wire strands, allow climbing 15 ft. before the first hook fouls the anchorage for one of the strands. The man then stops, disengages one hook only, and snaps it on again above the eyebolt, while the other hook remains engaged. After climbing 15 ft. further, the opposite hook is changed. He is always secured by at least one hook and he can under no condition fall more than 15 ft. Also, he must stop and rest, even if only for a few seconds, on every 15th rung. While this is not equal to a basket guard, at least in convenience, it certainly is better than no protection at all.

Fundamentals

While this article does not attempt to cover all conditions that face the designer, and some additional ingenuity is required, it does present some of the fundamentals of safe design. With these ideas as a base, obvious hazards can be avoided and satisfactory solutions to individual problems worked out within reasonable cost limits.

✦ ✦ ✦

Montaup's 1800-Lb Top Turbine Will Do 10,500 Btu

► SERVED by the first forced-circulation boiler to be installed in a public-utility central station in this country, a General Electric topping turbine-generator unit of 25,000 kw at 0.875 pf is expected to reduce present good-load-factor performance of 14,350 Btu per kwhr to 10,500 Btu or better. The boiler, a La-Mont unit built by Combustion Engineering Co (POWER, August, 1940, page 150), will operate at 2000 lb, 950 F.

The present generating station of the Montaup Electric Co at Somerset, Mass., comprises two single-casing, 1800-rpm units with direct-connected house-service generators. The first is rated 36,000-kw and the second newer unit at 40,000 kw. Both now operate at 365 lb and are provided with extraction feedwater heating.

The turbine, recently ordered, will exhaust at about 400 lb through flue-gas reheaters into present station headers. Operation in the late summer of 1941 is expected.

Boiler-feed supply at 2100-lb pressure requires a new approach to obtaining standby service. Spare turbine-driven pump with solenoid-operated throttle valve, suitable for lower pressures, falls down because pump-shaft packings that will not leak at standstill cannot be expected to come up to 3600 rpm in a few seconds with safety.

A scheme devised by Stone & Webster engineers collaborating with the Ingersoll-Rand Co, proposes to run two pumps practically all the time. Each turbine-driven pump will carry half the load, up to about 325,000 lb per hr each, requiring around 1050 hp on the turbine. If either of the running units fails, the other can deliver the full flow with speed increased to 4000 rpm and the turbine delivering about 2200 hp.

To suit station heat balance, substantially 70% Rankine efficiency under normal load conditions was required of the boiler-feed-pump turbines. Three multi-stage General Electric sectional-ized-valve-gear units of 2200 hp each meet these conditions and will be installed on the turbine floor level so that they will get the same operating attention as the main unit.

[*Editor's Note—These interesting details were excerpted from a report by Elmer Smith, District Turbine Specialist, General Electric Co.*]

Kentucky Utilities Plan Power Station

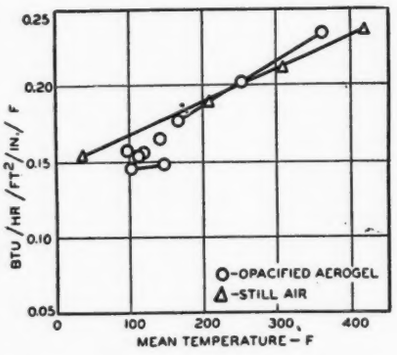
Plans for the construction of a $3,000,000 steam-electric generating plant on the Kentucky River near Tyrone, by the Kentucky Utilities System, have been announced by the president, Robert M. Watt. The proposed plant would be linked with the company's eastern power-transmission system. The new plant will have a capacity of 25,000 kw. No definite date for starting construction work has been set.

What's New in Refrigeration

Recently developed and improved materials, fresh light on old problems hold attention of refrigerating engineers at annual meeting

▶ DATA ON a new insulating material, a survey of refrigeration uses of aluminum, and an analysis of vibration isolation for refrigerating machinery were highlights, from the power engineer's viewpoint, of the 36th Annual Meeting of the American Society of Refrigerating Engineers, held Dec 3 and 4 at the Hotel Commodore, N. Y.

Silica aerogel, a comparatively new material, forms an unusually efficient heat insulator, having a conductivity coefficient lower than that of still air (see diagram). John F White, Monsanto Chemical Co, reported that this substance rates well in respect to moisture absorption and that under vibration aerogel will not settle more than any other fine granular material. Commercially available forms will pack to 7.5 or 8.25 lb per cu ft and a new form, under development, has a density of 3.75 lb per cu ft. Immediate advantages would seem to accrue from use of such a material in the field of refrigerated storage and transport where a decrease in volume of insulation required would markedly increase storage capacity.



Comparison of silica aerogel and still air

Savings in cost or weight, improvement in function and appearance and better performance under corrosive conditions often follow use of aluminum or aluminum alloys in refrigerating equipment, according to J R Willard and R B Mears, Aluminum Co of America. Properties of aluminum and its alloys differ widely (see table below); proper selection for service conditions is essential. In the commercial refrigeration and air-conditioning fields, aluminum fins or extended surfaces find use on both aluminum and copper tubing and aluminum tubing has been used for bare ammonia coils.

Starting with a clear explanation of vibration and isolation principles, Messrs J G Aldinger and E T P Neubauer, York Ice Machinery Corp, presented data on the problem of isolating vibration from machines with fixed unbalanced forces where mass must be added to reduce machine movement. The paper also included discussions of vibration transmission, of the problem introduced by consideration of more than one plane of freedom and concluded with examples of the application of isolation principles.

ALUMINUM ALLOYS COMMONLY USED IN REFRIGERATION

Alloy	*Temper*	*Composition*	*Tensile strength, lb per sq in.*	*Yield point,[1] lb per sq in.*	*Elongation[2] in 2 in., %*	*Forms in which generally used in refrigeration*
2S	O	Commercially pure aluminum, 99%	13,000	5,000	45	Sheet, extruded shapes, tubing, and rivet
2S	H	Aluminum	24,000	21,000	15	
3S	O	1.25% Mn, balance aluminum	16,000	6,000	40	Sheet, rolled and extruded shapes, tubing
3S	H	1.25% Mn, balance aluminum	29,000	25,000	10	and rivets
52S	O	2.5% Mg + 0.25% Cr, balance	29,000	14,000	30	Sheet and tubing
52S	H	aluminum	41,000	36,000	8	Sheet and tubing
53S	W	1.3% Mg, 0.5% Si, 0.25% Cr, bal-	33,000	20,000	30	Sheet, extruded shapes, tubing, forgings,
53S	T	ance aluminum	39,000	33,000	20	and rivets
61S	W	1.0% Mg, 0.6% Si, 0.25% Cu, 0.25%	35,000	21,000	22	Sheet, extruded shapes, forgings, and
61S	T	Cr, balance aluminum	45,000	39,000	12	tubing
Alclad 3S	O	This is a composite product with a	16,000	6,000	30[3]	Sheet
Alclad 3S	H	central core of 3S alloy and a coating on one or both sides which is of an alloy that will galvanically protect the 3S.	29,000	25,000	4[3]	Sheet
43	As Cast	5% Si, balance aluminum	19,000	9,000	6	Sand, permanent mold and die castings
B214	As Cast	3.8% Mg, 1.8% Si, balance alumi-	17,000	12,000		Sand, permanent mold castings
		num to	19,000[4]	to 13,000[4]	—	
356	T4	7% Si, 0.3% Mg	28,000	16,000	6	Sand castings
	T6	7% Si, 0.3% Mg	32,000	22,000	4	Sand castings
	T51	7% Si, 0.3% Mg	25,000	20,000	2	Sand castings

[1] Yield strength is the stress which produces a permanent set of 0.2 per cent of the initial gage length.
[2] ASTM standard ½ in. diameter specimen unless noted.
[3] ASTM standard 1/16 in. thick sheet specimens.
[4] Depends on whether sand or permanent mold cast.
Alloys 2S, 3S, and 52S, and Alclad 3S are supplied in five tempers: O (annealed), H (full work hardened), ¼H, ½H, and ¾H intermediate amounts of workhardness. Alloys 53S and 61S are supplied in the O (annealed), W (heat treated), and T (heat treated and aged) tempers.

How to Protect Motor and Generator Field Coils

S B Griscom, central station engineer, Westinghouse Electric & Mfg Co, tells how and where to use constant resistors, variable resistors, lightning arresters, capacitors, and copper-oxide rectifiers to protect field coils against high induced voltages

WHEN THE FIELD current of a motor or generator is interrupted, the stored energy must be dissipated in some manner, otherwise voltages high enough to damage insulation are likely to result. The time-honored method of protection is by a "discharge" resistor, Fig. 1. The discharge clip *A* is arranged mechanically so that it closes slightly ahead of the main contact opening. This insures that the discharge resistor is connected across the field when the current is broken.

Voltage developed at the instant of opening an inductive circuit is proportional to the product of inductance and the rate of current change through the inductance. In practice, the induced voltage across a field-coil circuit, opened without a discharge device, is not determinable. Assuming that the field current is interrupted abruptly by the circuit breakers, then the current must change instantly from its initial value to zero. This represents an infinite rate of change of current, hence an infinite voltage would be created across the field coils.

Long before the infinite voltage is reached, however, the voltage generated is sufficient to strike an arc across the breaker contacts and the current flows until the combination of widening contact separation and reduced current finally cause extinction of the arc. At this time and during the opening there are abrupt rises which may reach several thousand volts. Actual magnitudes are not predictable because ionization in the arc varies, and eddy currents in the field structure influence the results.

It is common practice to assume instant and complete transfer of the field current from the source to the discharge resistor when the breaker opens, and to use such a value of resistance that a safe voltage (approximately 600 volts for 250 volt fields) is not exceeded. For example, if the generator field current is 200 amp, a discharge resistance of approximately 3 ohms would be used. Then, with instantaneous transfer of current from the exciter to the discharge resistor, the voltage would not exceed 600 volts.

One of the methods of protecting motor and generator field coils against high-voltage surges is by using electrolytic lightning arresters

Excitation—Bus Operation

When generator fields are supplied from an excitation bus supplied from two or more exciters, the problem of protection against discharge voltages may be somewhat more complicated. If the number of exciters is small, and there are no complications due to sectionalizing or transfer buses, the arrangement of resistors, Fig. 2, is effective and economical. Here the discharge clips of the exciter breakers are connected in series with the resistor across the bus. As long as one exciter feeds the bus, the resistor is out of the circuit. However, if the last exciter is removed from the bus, the discharge resistor is connected into circuit, and the stored energy of all of the alternator-field coils is discharged through it.

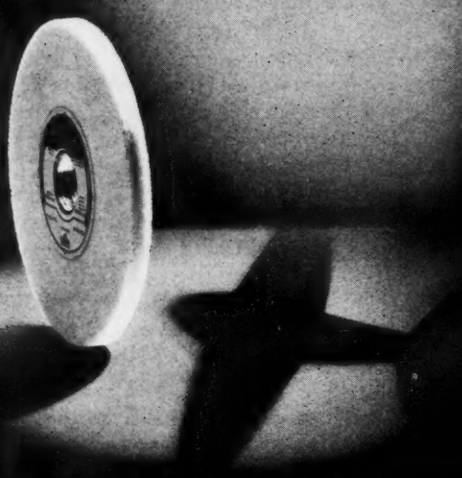
Sometimes the scheme, Fig. 2, cannot be used readily, as where sectionalized main and transfer excitation buses are being used. Then the various sections would need to be individually protected. Since the number of possible combinations of machine group-

(Continued on page 92)

NORTON ABRASIVES

Abrasives Conquer Modern Alloys

Far greater dependability went into the airplane when the metallurgist produced new and tougher alloys—but they were of little worth without abrasives, primarily the grinding wheel.



WHEN IT'S A GRINDING PROBLEM, CALL IN NORTON ENGINEERING SERVICE

Norton Company

another leader of industry

called in RILEY

Tests show that the two Riley units they installed operate at 89.3% efficiency . . . 2.6% higher than guaranteed.

A study of power and steam costs prepared by their consulting engineer, Francis J. Sill, for the Norton Company, indicated worth-while savings through the installation of modern high efficiency steam generating units and power generating equipment.

Two 50,000 pounds per hour, 725 pound, 750° F. Riley "RP" Steam Generating Units equipped with economizers and air heaters and fired by Riley Pulverizers were installed. Tests show these units to be operating at 89.3% efficiency, with exit gas temperatures of 303 degrees against a guaranteed efficiency of 86.7%. It has been so characteristic for Riley Units to operate at capacities and efficiencies in excess of guarantees that most purchasers have come to expect this plus value and their Riley Units invariably meet their expectation. A plus value that gives them more than their money's worth when they purchase Riley equipment.

It is because of such outstanding performance, because of complete satisfaction from the performance, maintenance, reliability and continuity of operation standpoints that so many of the leaders of industry have come to Riley for the best solution of their steam generation problems.

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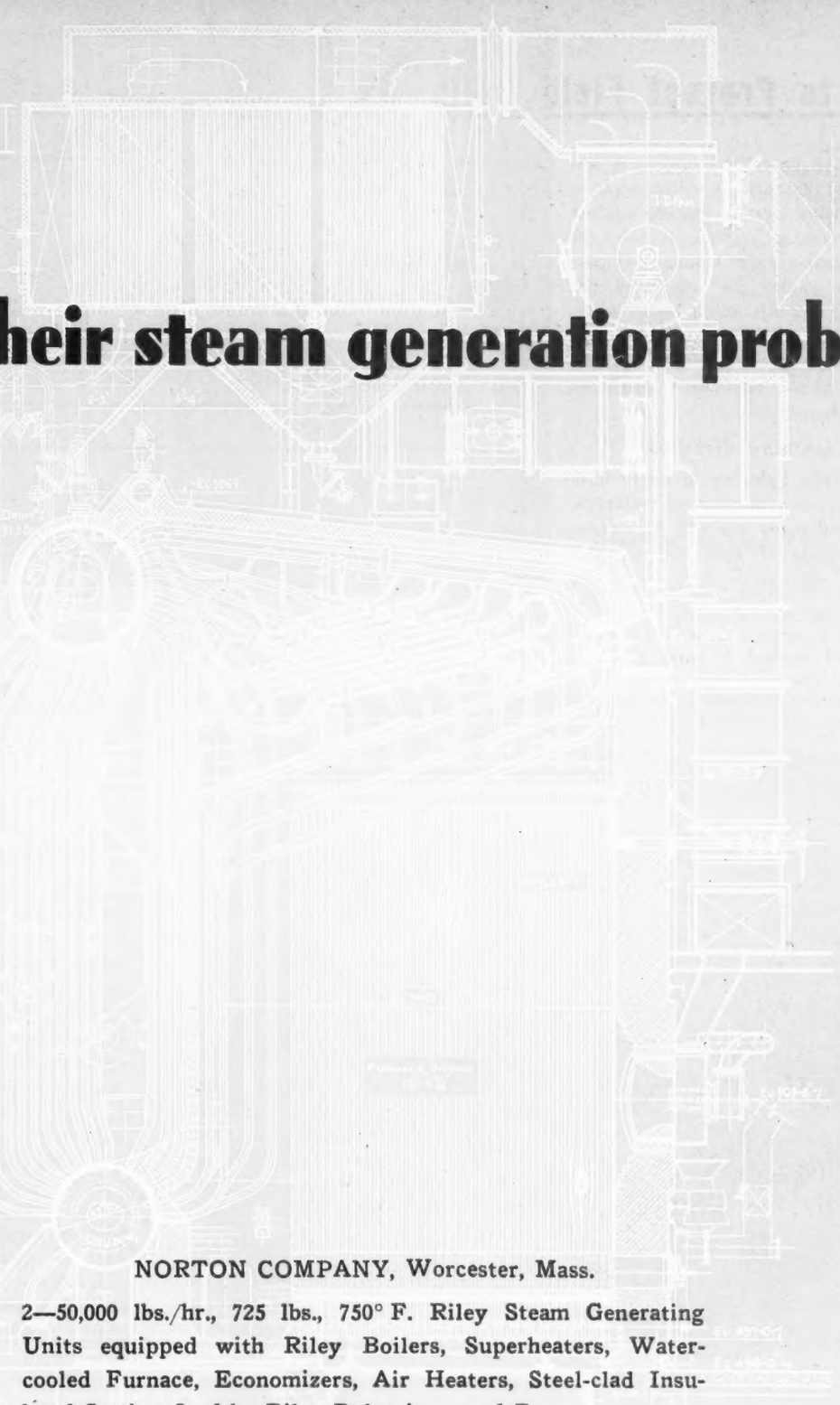

NORTON COMPANY, Worcester, Mass.

2—50,000 lbs./hr., 725 lbs., 750° F. Riley Steam Generating Units equipped with Riley Boilers, Superheaters, Water-cooled Furnace, Economizers, Air Heaters, Steel-clad Insulated Setting fired by Riley Pulverizers and Burners.

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before purchasing Boiler or Fuel Burning Equipment

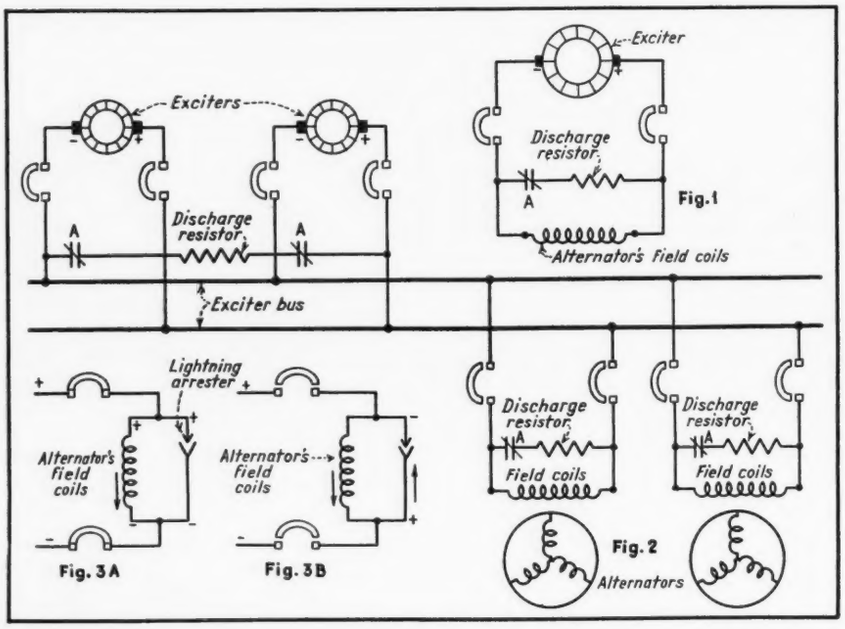
How to Protect Field Coils

(Continued from page 89)

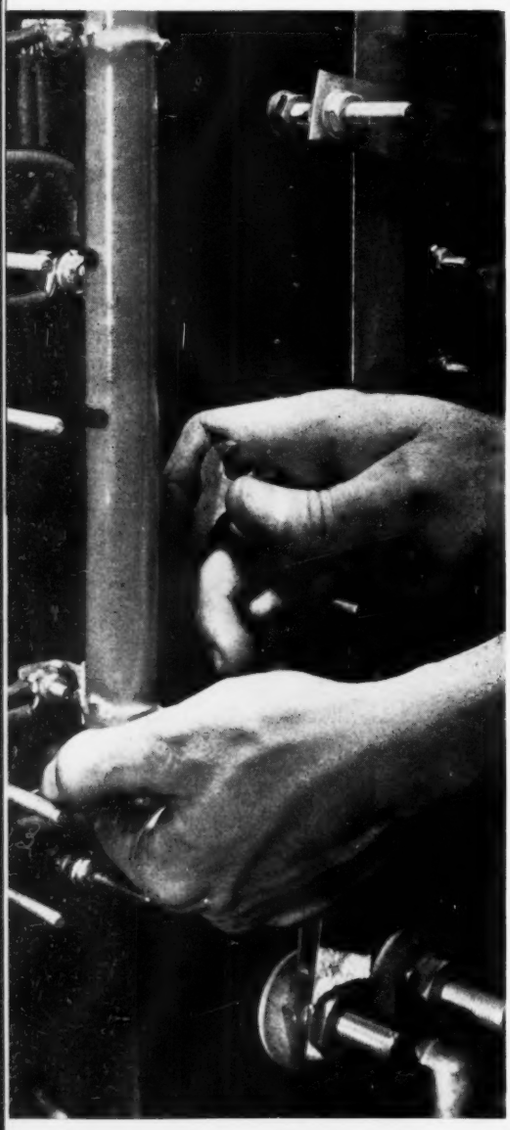
ings on the buses is large, it is impossible or impractical to interlock in such a manner as to provide against all contingencies. While transfer of the discharge circuits manually is possible, this cannot be considered dependable. For this reason some inherent means of protection is desired. The following represent some of the schemes which have been used, or considered.

Lightning Arresters

Electrolytic lightning arresters have been used in a number of instances, and a good many are still in service. The principle of operation depends upon an electrolytic film which, in normal operation, is built up on one side of the plates. This film is thick enough to prevent any substantial flow of current, Fig. 3*A*. When the supply circuit is opened, however, the polarity of voltage applied to the cells is reversed. Since no film has been built up in this reverse direction, the only resistance offered is that of the electrolyte, which is very low and a current flows, Fig. 3*B*. While the thermal capacity is fairly high, the proportion of water being large, it cannot be used to full advantage, because of the possibility of local heating.



Figs. 1 to 3B—Diagrams of connections for protecting motor and generator field coils with resistors and lightning arresters



Time-honored method of surge protection for machine field coils is the discharge resistor. Here one is being installed on the rear of a motor-control

Electrolytic Cells

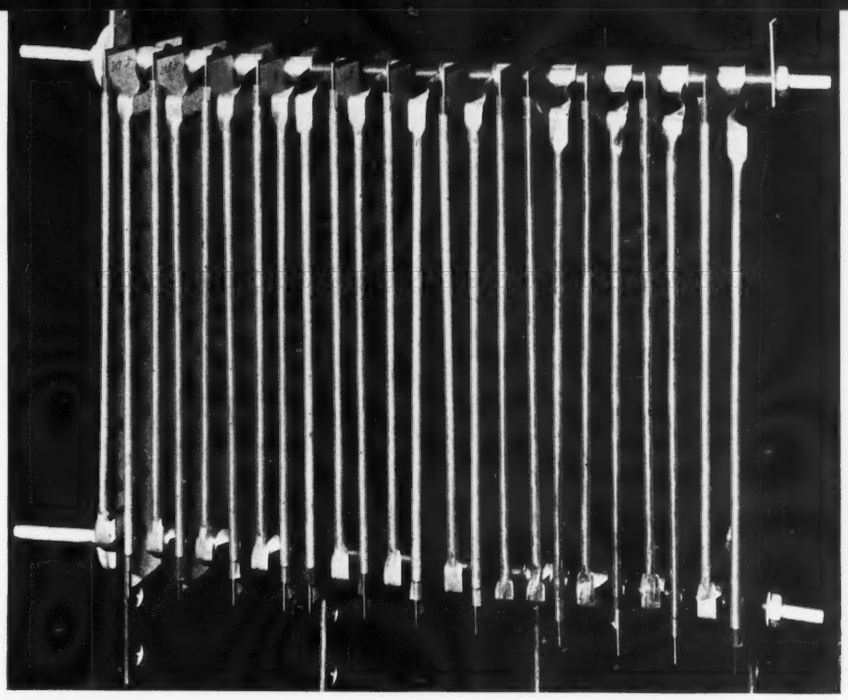
Two electrolytic cells are customarily used in series in a conservative application for 250-volt fields. In the glass-jar type, these two cells will handle approximately 140,000 watt-seconds of stored energy. This corresponds approximately to the magnetic energy stored in a 20,000-kva turbine-generator, although the stored energy varies considerably for a given rating, depending upon speed, short-circuit ratio, and other factors. For larger machines more units in parallel must be used.

Electrolytic arresters have the advantage of being about the least expensive device that can be used for protecting field coils against excessive induced voltages. However, they require maintenance and replacement of parts. When the cells remain de-energized for long periods, provision for charging before placing them across the line may be necessary. Their effective resistance increases after a discharge because a film is built up in the reverse direction, and some time is required for this to redissolve. They are obsolete equipment with most manufacturers, and some time may be required to get replacement parts.

As an alternative, the dry-type valve arrester has been suggested as a possible field-discharge device. However, it is in general not suitable. It can discharge large currents for a few hundred microseconds, but the time constant of a generator field averages about 3 sec. This means that at the end of 3 sec. the closed-circuit discharge voltage will be down to only 37% of its initial value. When discharging through a resistor the time is shorter. Nevertheless, the time is entirely too long for the conventional types of valve arrester, and local heating and destruction of valve characteristic take place.

Variable Resistors

Permanently connected to the excitation source, variable resistors have been used in some cases as discharge devices. Resistors for this purpose have negative-resistance characteristics with current, that is, as current increases, resistance decreases. This characteristic gives the possibility of limiting the



Frequently used in control circuits to absorb the discharge from contactor coils, copper-oxide rectifiers, such as this one, are suitable for field protection

overvoltage during discharge without drawing an undue loss current during normal operation. In order to satisfy these two requirements of low loss at normal voltage and low voltage on discharge, it is frequently necessary to use a large amount of material with consequent high price.

Electrostatic capacitors have been suggested from time to time as possible discharge devices. However, they are totally unsuited to large machines, as a brief analysis will show. Take the case of a 20,000-kva turbine-generator having a stored magnetic energy of 140,000 watt-seconds. This is to be discharged into a capacitor with a voltage not to exceed, say, 600 volts. The stored energy of a capacitor is half the product of its capacitance in farads and the voltage. Thus, for 600 volts, the capacitance must be 0.75 farad or 750,000 microfarads, which is impracticably large.

Copper-Oxide Rectifiers

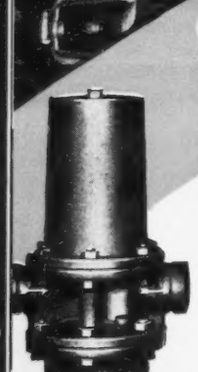
In a number of instances, copper-oxide rectifiers have been used for absorbing the discharge of contactor coils and similar devices in control circuits. It is suitable as a field-discharge device, and its action is similar to the electrolytic lightning arrester. Figs. 3A and 3B, for it presents a high resistance to the flow of current in one direction and a low resistance for reversed polarity. The advantage of this scheme is its reliability and freedom from maintenance. Its chief disadvantage is its high cost, because several units must be connected in series to hold back normal voltage, and a sufficient number must be used in parallel to pass properly the discharge current.

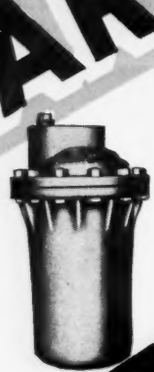
After careful analysis one must conclude that the conventional resistor, cut in and out by discharge clips on the main field breaker is generally the most economical and satisfactory device. Where, because of some unusual condition, this cannot be used, the electrolytic arrester, variable resistor, or copper-oxide rectifier schemes appear to be the only feasible alternatives. The choice between these is a matter of local circumstances and opinion, regarding maintenance, cost and space factors.

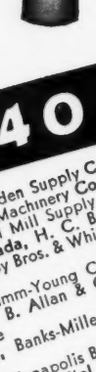
Inspecting the brushes and exciter commutator for a large steam-turbine-driven generator. The exciter furnishes direct-current voltage for the field coil of the large generator to which it is connected

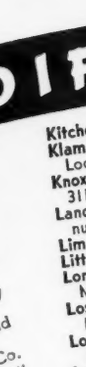
ARMSTRONG TRAPS

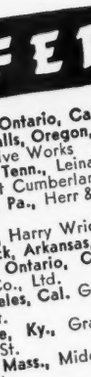
STOCKS LOCATED AT 140 DIFFERENT P

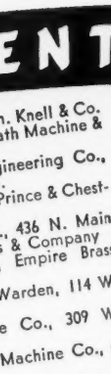












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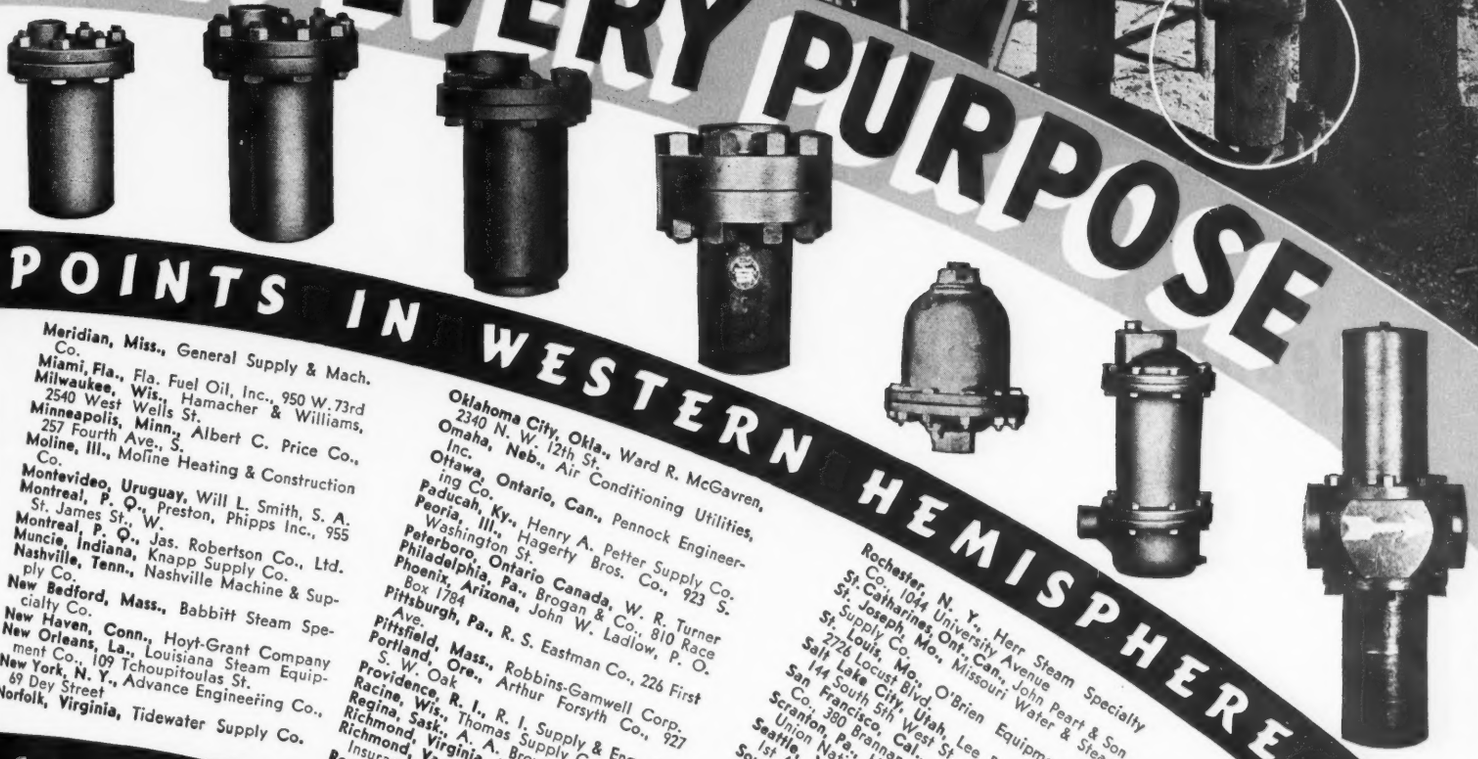
FOR EVERY PURPOSE



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TRONG

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THE FACTORY—The Northwestern Corp, Morris, Ill., turns out from 200 to 300 vending machines a day

Peanuts, Postage Stamps and Diesels

▶ WHEN YOU PUT a penny in a slot and get back a handful of salted peanuts, or when you need a 3-cent stamp or some matches and have them offered you by a vending machine, chances are you use a machine made by the Northwestern Corp, Morris, Ill., world's largest manufacturer of this equipment.

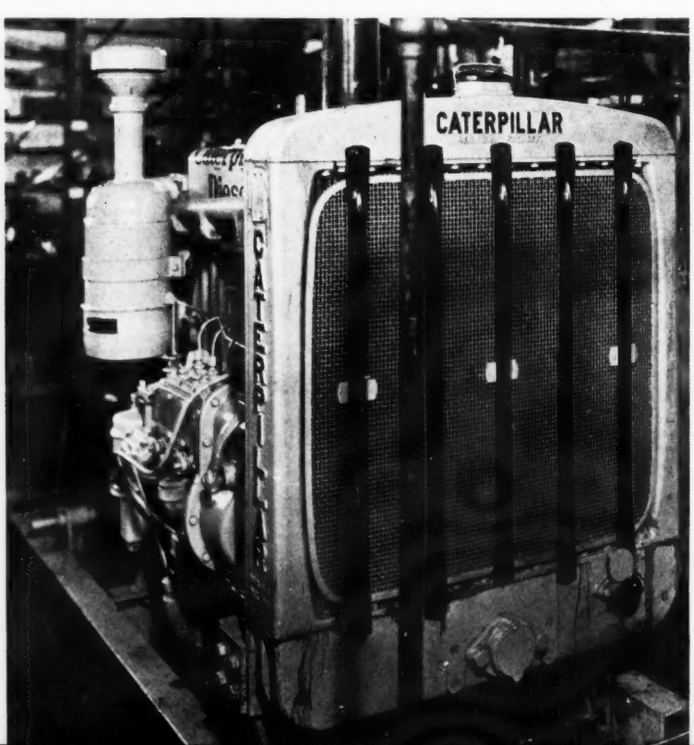
In its modern, up-to-the-minute factory, Northwestern Corp depends entirely on diesel power to manufacture the 200 to 300 vendors it turns out each day. All parts, including the finely balanced mechanisms and aluminum castings for the cases, are made in the diesel-powered factory.

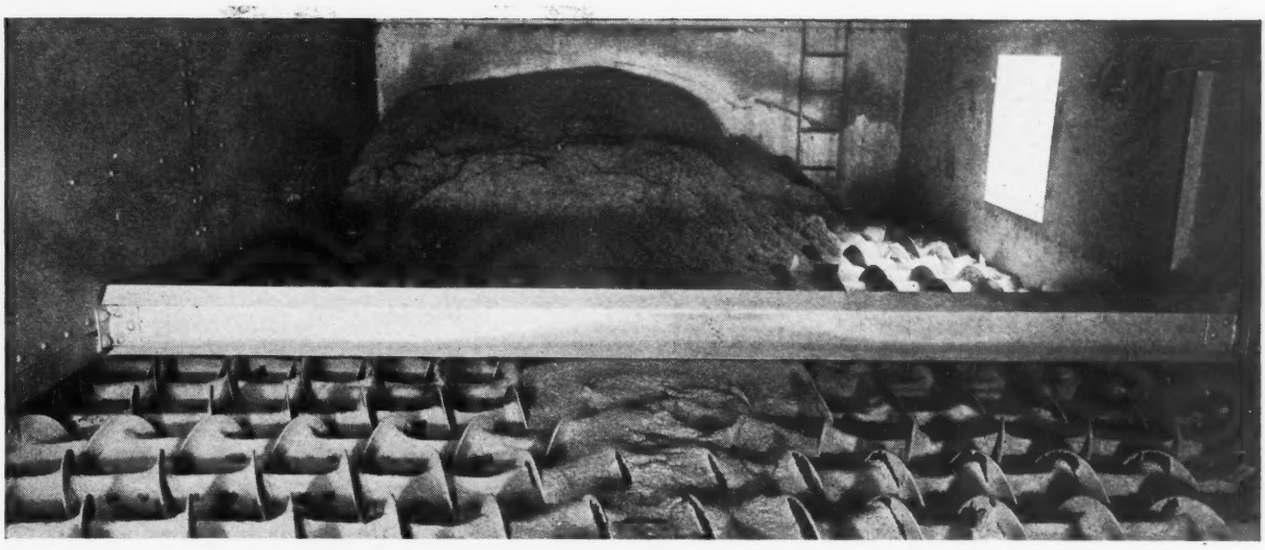
Two engines supply all power needs; one, a 3-cyl, 60-hp Caterpillar, driving a 30-kva generator through V-belts, provides power requirements of the following equipment: air compressors, polishing lathes, furnace and exhaust fans, punch presses, saws, foundry blowers, surface grinders, etc. The smaller diesel is connected by flat belt to line shafting, and powers several cutting, polishing and finishing machines.

The 60-hp unit runs eight hours a day during the week, and half a day on Saturdays. Both engines are in a corner of the main machine shop, available for servicing and inspection.

THE PRODUCT—Mechanism assembly line of Northwestern Corp factory, which makes vending machines for peanuts, postage stamps, matches, etc

THE POWER—Caterpillar, 3-cyl, 60-hp diesel V-belted to a 24-kw generator supplies most of the power needs. A smaller unit backs up the line





Thirty spiral feed screws form live bottom in 12,000-cu-ft storage bin

Three Years' Experience with A Modern Wood-Waste-Burning System

Reliability, efficiency, ease of operation mark performance record of Heywood-Wakefield Co's plant for burning wood refuse and pulverized coal, separately and in combination

By K R WARRINGTON

Francis J Sill, Consulting Engineer, Westboro, Mass.

► RELIABILITY, efficiency, and ease of operation of a modern system for conveying and burning wood waste, either separately or in combination with pulverized coal, have been proved by three years' experience at the Heywood-Wakefield Co's plant at Gardner, Mass.

In 1936, this company, prominent manufacturers of seating equipment for cars, busses, theatres, and schools, and makers of a famous line of wood furniture, faced the necessity of replacing their steam plant, which was old and inadequate. In addition, the old power plant, in the center of one of the main factory buildings, occupied space greatly needed for manufacturing purposes. The organization with which the writer is associated was retained to design and construct a modern power plant in a suitable new location.

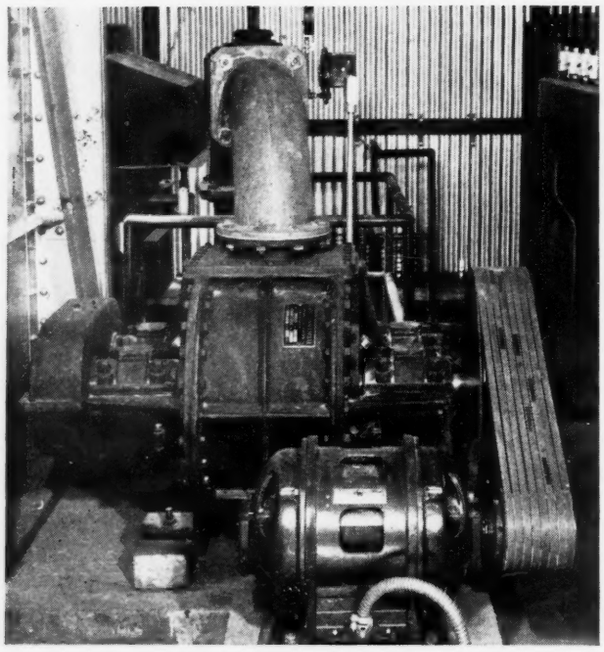
Erecting the new plant on land across a street and opposite the factory made space taken by the old plant available for manufacturing; it brought the power house closer to the center of steam and electrical distribution, closer to the source of wood-waste production in the factory, and removed from danger of factory fires. However, it was necessary to tunnel through solid rock under the street to connect, with piping and cable, the factory and the new power house.

The new boiler plant comprises two Babcock & Wilcox Type F units, for a maximum steam pressure of 300 lb g, and 200 F superheat, each having a continuous maximum capacity of 60,000 lb per hr. Turbine-generator units (DeLaval) produce most of the factory's electrical needs as a byproduct of the steam required for dry kilns, wood bending, building heating, etc; partial condensing operation produces the remainder.

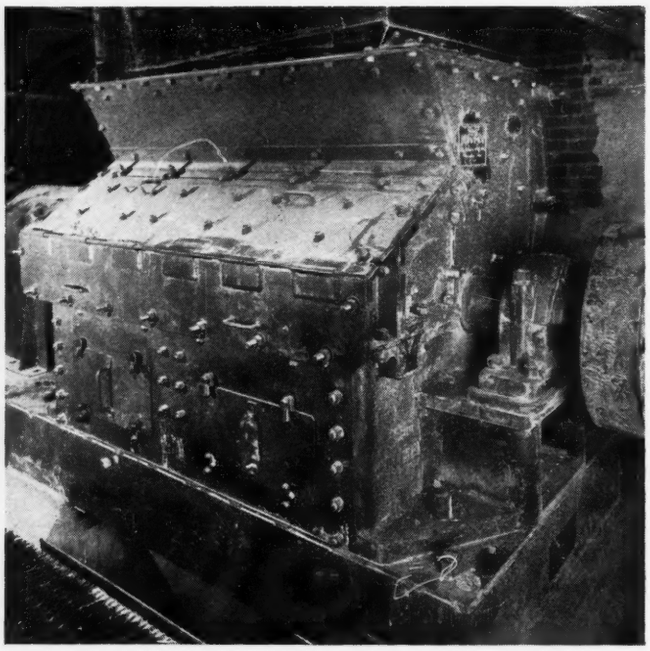
Manufacturing operations result in large amounts of kiln-dried hardwood refuse, mostly birch and maple, which must be removed from the factory within a few hours to avoid obstructing manufacturing space. This waste forms a potential source of economical boiler fuel. However, amounts available vary with the ratio of wooden to metal furniture in process and the volume of business; there are periods when steam is required but no refuse is available. It is, therefore, necessary to burn another fuel to generate sufficient steam and electricity to accommodate all factory requirements.

Coal Chosen as Fuel

Coal was determined as being the most economical fuel available in the vicinity of Gardner for use as an auxiliary fuel for boilers normally burning wood refuse. In most power plants where wood refuse and coal are fired in the same furnace, the coal is burned on grates or stokers and the wood refuse merely dropped on top of the burning coal. However, at Heywood-Wakefield the economic importance of burning wood separately for long periods eliminated consideration of conventional stokers. Installation of pulverized-coal equipment for auxiliary firing permitted designing furnaces to burn either or both fuels. Two Riley pulverizers, two burners and two Clarage forced-draft fans were installed for each



High-pressure blower supplies air to 6-in. line conveying wood refuse from storage bin to boilers



This shredder can reduce 5 tons per hr of butts and sticks to splinters not over 5 in. long

boiler. The pulverized-coal burners were set one above the other in the furnace front wall.

Naturally, wood waste accumulates in the factory at a rate depending on the volume and type of business; this rate does not necessarily coincide with steam and electrical demands. This means that ample storage facilities for wood waste must be provided to take care of differences in the two rates. A 12,000-cu-ft steel storage bin, near the main source of wood waste at the factory, serves this purpose. Thirty spiral feed screws (Jeffrey Mfg Co) form a live bottom in the bin, readily removing wood from all sections.

The wood refuse comprises many shapes and sizes, including butts, sticks, shavings, sawdust, etc. Obviously, the finer the wood refuse entering the furnace, the greater will be the number of carbon surfaces that can be exposed to action of oxygen to produce complete combustion in the least time. A Jeffrey wood shredder near the storage bin reduces 5 tons per hr of wood butts, sticks, etc, to splinters not over 5 in. long. A fan system (Sturtevant), using low-pressure air for conveying, removes this reduced size of wood from the bottom of the shredder and deposits it in the storage bin.

Ten motors drive the feed screws at the bottom of the bin, which are arranged in batteries of three. Hand-operated switches mounted on a panel in front of the boilers give remote control of these motors. A neon lamp opposite each switch on the panel shows the operator the number and sequence of batteries of conveyors in action. This simple arrangement permits the operator to control the amounts of wood entering the furnace to maintain constant steam pressure at varying steam loads.

Mechanical difficulties of conveying the shredded wood several hundred feet and introducing it into the furnaces for maximum combustion efficiency complicated the problem of transportation from storage bin to boilers. With many changes in direction and elevation between the storage bin and boilers, mechanical conveying appeared undesirable because it would require a large amount of space in the tunnel under the street and a complicated and expensive arrangement.

Pneumatic Conveyors

Conventional pneumatic systems for conveying wood refuse consist of fans using large quantities of low-pressure air, thus requiring large pipelines, cyclones, etc. These often interfere with efficient combustion. Many conventional conveying systems were investigated but discarded as uneconomical in operation or not insuring efficient combustion.

A high-pressure pneumatic system developed by the United Conveyor Corp for moving other materials was also investigated and although it had not been tried on wood refuse its characteristics of operation appeared satisfactory for this purpose. Accordingly, a system of this type, capable of handling 9000 lb of wood per hr, was developed by this office, in collaboration with United Conveyor Corp, and installed. It consists essentially of a motor-driven air lock for receiving wood from the feed screws of the storage bin, and a motor-driven high-pressure Roots-Connersville blower. To control the amount of air entering the system, the blower obtains its supply independently of any other source. A motor-driven spiral conveyor delivers wood from the 30 storage-bin screws to the air lock. Wood discharges from the air lock into a 6-in. pipeline just ahead of the blower; air at a pressure of approximately 2 lb g conveys the waste to the boilers.

To control burning of wood waste in the furnace and to prevent burning-back in the 6-in. line, with resultant danger to personnel and equipment, the amount of air entering the furnace with the wood must at all times remain insufficient to support combustion. The quantity of air used to convey wood in the 6-in. pipe stays at a constant value below the theoretical air for combustion of the minimum amount of wood conveyed (output of one battery of feed screws in the storage bin).

In case large pieces of wood or foreign material clog the conveying system, a device actuated by air pressure in the 6-in. line automatically shuts down all feed-screw motors and the air-lock motor, stopping flow of wood waste into the system. The device operates if air pressure in the 6-in. line exceeds a pre-determined level. Increased pressure acts to clear the line of all minor obstructions and after pressure drops back to a safe operating level the de-

vice will automatically start feed-screw and air-lock motors. Operation of the high-pressure blower is not interrupted during this cycle.

The 6-in. line, which constitutes the sole conveyor between the air lock and the boilers, discharges into two furnace-inlet boxes on the flat arch forming roof over the furnace of each boiler.

The boxes serve to spread out the streams of wood entering the furnace and were placed a considerable distance from the pulverized-coal burners to prevent interference with their operation.

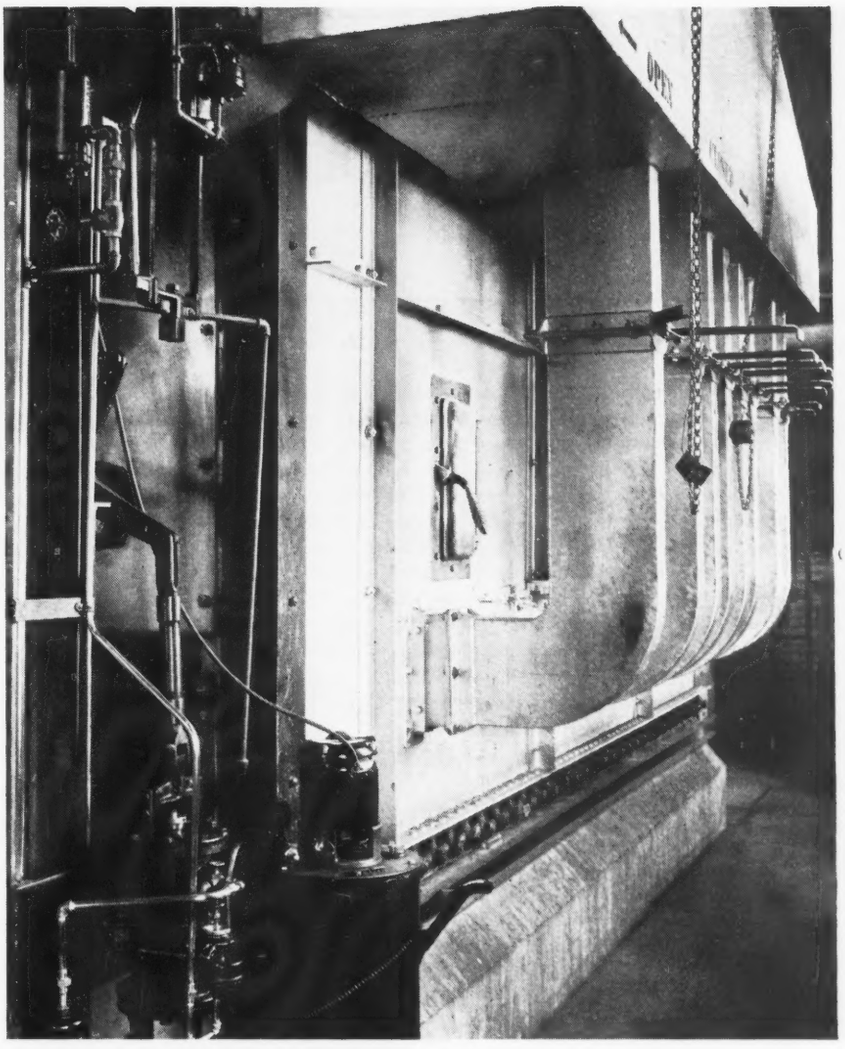
The secondary-air system, for wood-waste burning, consists of eight small ducts running from the main forced-draft ducts to eight ports in the furnace sidewall of each boiler, under the wood-inlet-box openings. These ports are at a common height just above the furnace floor. A hand-operated damper in each secondary-air duct permits control of amount and location of air supplied, to help burn wood accumulated on the furnace floor. A Hagan automatic combustion-control system regulates operation on pulverized coal and also maintains constant negative furnace pressure and constant positive forced-draft-duct pressure for firing either fuel alone or in combination.

How Burning System Works

The wood-refuse burning system was expected to work as follows: Falling wood refuse would meet rising secondary air and would, for the most part, burn in suspension. Larger pieces would fall to the furnace floor where they would accumulate and burn under the action of secondary air jets from the sidewall ports. Heat from this accumulation on the floor would radiate to the top furnace arch which would help ignite wood entering the furnace. Small sized particles produced by shredding would reduce combustion time to a reasonable amount and feeding the wood from the furnace top would meet this time requirement amply. Air for conveying, entering the furnace with the wood, would maintain agitation and aid in combustion.

Furnaces were designed as a compromise for burning both fuels but, in order to burn pulverized coal efficiently, without excessive maintenance cost, water-walls and water-cooled floors were installed in each furnace. Experience shows that less efficient operation always results when burning two or more fuels in combination because amount of air supplied must be a compromise and the result may be an inefficient mixture for either or both fuels.

In 1937, the first of the new boilers went into operation on pulverized coal.



Eight secondary-air ducts in furnace sidewall speed burning of wood refuse accumulating on furnace floor

After this equipment had been adjusted and satisfactory operation obtained, it was decided to operate this boiler on wood refuse alone, to handle relatively light night loads. The conveying system operated satisfactorily but it appeared evident that wood refuse could not be burned fast enough to maintain constant steam pressure under maximum demands that might be expected to occur at other times.

Opening or closing any one of the dampers in the secondary-air ducts did not appear to make any material difference in the amount of time required to consume wood refuse on the furnace floor. Most of the wood accumulated on the floor and it proved necessary to lance it with air to burn it fast enough even during periods of relatively low steam loads.

Observation revealed that although the wood refuse entered the furnace through the top arch near the furnace sidewall containing the secondary air ports, it accumulated on the furnace floor much farther away from the air ports. This resulted from installing the inlet boxes perpendicular to the top furnace arch, which runs about 15 deg off horizontal. Changing the boxes so that their sides were truly vertical allowed the larger pieces of wood to accumulate directly under the inlets and nearer to the secondary air ports in the sidewall.

After this change had been made during the night, the boiler took morning loads on wood refuse only. It proved possible to control the secondary air to the wood accumulation on the furnace floor and to handle a steam demand of 35,000 lb per hr without lancing or forcing any part of the system.

This boiler operated steadily for a period of several weeks, meeting all steam demands, which reached at times a maximum of 45,000 lb per hr, on wood only. During this time, pulverized-coal burners were exposed to ra-

(*Continued on page 140*)

Speaking of Power

It has long been our custom to start the new year with an extended review of the power progress of the 12 months just closed. That's one custom, but you may have observed another POWER custom—to break with tradition whenever there is anything to be gained by a new tack. . . . For example, we are omitting the January review this time because we now regularly sum up for diesels in June, for steam plants in September, and for equipment in Mid-December. . . . Just for old times sake, however, let me give you an engineer's newsreel impression of men and events of 1940.

On February 27, 1940, "America's Modern Pioneers"—men who have contributed much to civilization through science and invention—were

Priceless assets . . .

honored at New York's Waldorf-Astoria Hotel. . . . Among the 19 listed were Willis H Carrier (air conditioning), Frederick G Cottrell (electric dust precipitation), Charles Kettering (self starter and diesel engines), Irving Langmuir (electric lamp progress). Such men are priceless assets to any country.

Speaking of prominent engineers, I must mention, among many, two men who died last year—C F Hirschfield and Lester P Breckenridge. Dr Hirschfield, Detroit Edison's chief of research, was an outstanding power engineer; Professor Breckenridge an outstanding maker of men, of engineering men. . . . Thus does nature, through death,

Among the honored . . .

constantly deplete our resources of brain, spirit and initiative. At the other end of the line she constantly replenishes the reservoir through birth. . . . But we never know when a great engineer is born—only when one dies.

Elsewhere and everywhere much is being written and said about the Second World War—the less noted here the better. But the defense program was *the power* event of the year, for factory production is the back-bone of modern mechanized war, and power is certainly the backbone of production. . . . America's power plants were a little ahead in their preparations. So far they have created no "bottleneck", and we don't expect they will—*if power engineers keep on the job* . . . With defense preparedness came a tightening

The power event of the year

up on protection against plant sabotage. Looks like we shall need more of that before we get through.

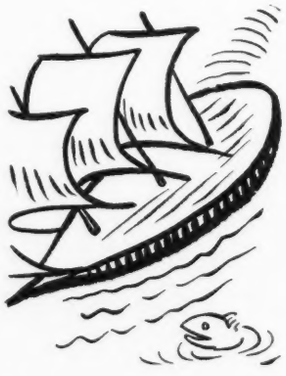
Maybe (but I guess not) future generations will remember 1940 not so much for the Second World War as for the proof that Uranium 235 can release 37 billion Btu per lb (as much as 1370 tons of coal) in a "self-propagating chain reaction". Uranium 235 is mighty hard to isolate, so practical atomic power still seems far away.

And here are some other items, big and little, from 1940: The whole bituminous coal industry went under government-regulated price control. It is now "agin' the law" for a producer to sell his coal at a price lower than the government-approved schedule. . . . St Louis told its smoke makers "either you put in approved firing equipment or you stop burning smoky Illinois coal". The big stick replaced "moral 'suasion" in St Louis' attack on smoke. We hope it works.

Coal under gov't control

Panel heating, still in the "pilot-plant" stage, began to get real attention last year. Its wider application will await development of practical details, also a better public undersanding of the philosophy that heating systems don't heat people, that man supplies his own heat and that the function of the heating system is to keep him from losing his own too fast for comfort.

Finally, let me remind you that large-scale wind power is not dead, in spite of the



Wind power isn't dead

abandoned Madaras experiments of several years ago. . . . Under the sponsorship of S Morgan Smith, with the cooperation of other leading firms, work has been started on an experimental 1000-kw wind-power plant at Grandpa's Knob, Vermont. Should be completed in the first half of 1941.

I should like to take this opportunity to wish every reader of POWER a Happy New Year. We editors enjoy serving the practical men in a field so vitally important to the national well-being—*Phil Swain*

THE OPERATING ENGINEER

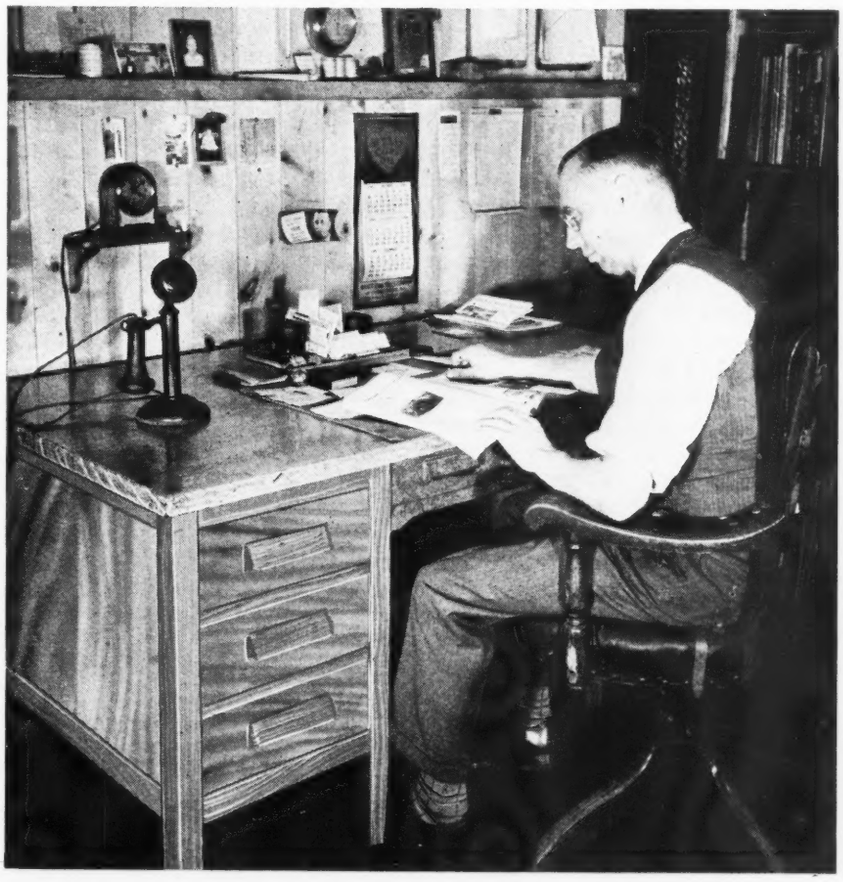
George Edwards
Advisory Editor

Practical Aids
Maintenance Hints
Questions — Answers

Published monthly as an integral part of POWER

Simplicity Keynotes This Plant's Motor Maintenance Program

Simple but effective inspection and maintenance schedule kept 767 motors on the job at a repair cost of less than 10 cents per unit during 1939



William T Estlick, plant engineer, applies a simple system of inspection and maintenance to achieve high equipment reliability at low cost

SIZE OF PLANT, product manufactured, whether power is generated or purchased, are prime factors determining how large an organization must be to operate power and other service facilities. A medium-size plant with light machinery can be operated and maintained with a more simple organization than a large industrial manufacturing a product requiring heavy machinery.

Guided by this philosophy, William T Estlick, plant engineer, The Ansonia O & C Co, Ansonia, Conn., has developed his operating department to achieve exceptionally high equipment reliability at low operating cost.

Steam and Power Demands

This company employs about 550 persons in its Ansonia plant and manufactures high-grade elastic webbing, hose supporters, shoe and corset laces, and similar articles. Three hand-fired boilers generate steam for process and heating at 80 lb g. Because steam requirements for process are comparatively small, all power is purchased from the local utility.

Manufacturing machines are group and individually driven by 767 motors ranging in size from 50 to less than 1 hp. Most of the motors are 3-phase, squirrel-cage design, a few are wound-rotor units; some single-phase capacitor and repulsion fractional-hp motors power very light machines.

The present system of operation is the development of more than 20 years experience. When the steam plant was put under Mr Estlick's charge in 1918

it was in bad condition and was burning over 3000 tons of coal per year. In 1939 coal consumption had dropped to 1750 tons, less than 60% of the 1918 figure. In both years power used was practically the same, 825,000 kwhr, but, because of improved manufacturing processes, production in 1939 was considerably higher than in 1918. Thus, reduction in amount of coal burned has been entirely a result of improved operation.

The new engineer's first step was to put the boilers and settings in first-class condition and to keep them that way. All waste from the manufacturing processes, carpenter shop, shipping and receiving rooms, and from other sources, is burned in one of the boiler furnaces. At one time, this material was disposed of as it came to the boiler room with no thought to burn it efficiently. Now, it is stored until a certain time each day and then burned under one boiler to produce a maximum of steam.

Saving Btu's

Mr Estlick also gave considerable attention to saving heat out in the plant. Pipelines had been extended to meet changes in process and expansion with no thought to proper coordination. As a result, there was much unnecessary piping and much of it poorly insulated. All excess piping is now gone, lines are run as directly as possible and no more Btu's are allowed to wander off if they can be coupled up by proper insulation.

Another important step in obtaining low coal consumption was careful temperature control in different departments during the heating season. Before this was done, a great deal of overheating occurred, with consequent opening of windows and loss of heat. Now, thermometers at key points guide maintenance men and watchmen on their rounds, who adjust steam valves to maintain a temperature of not less than 72 F, or not more than department requirements.

Water used for all purposes amounts to about 2,250,000 cu ft per year, all of which was purchased at one time. Digging a well and installing a pressure pumping system to supply water for general service, process and boiler feed, reduced purchased water to about 250,000 cu ft a year. Well water has proved much more satisfactory for processes because of its more constant quality. Moreover, once the correct treatment has been set up for well water to be used in process, it does not have to be changed again; with purchased water the treatment must be varied to suit the changes in water quality.

This is part of the spare-motor stock ready to replace any unit that shows signs of laying down on the job

Maintaining electric motors and controls is one of the major operating jobs. Mr Estlick holds to the theory that good maintenance begins with the selection and installation of the equipment and that the maintenance job should be made as simple as possible. Thus, practically all motors are of one make and operate at 1200 or 1800 rpm. This simplifies stocking spare parts and makes it economically possible to have a spare motor for every essential drive. It also simplifies inspection and repair work.

In selecting the motors and control, effort was made to use standard equipment only, and where possible, units with simple across-the-line starters. Using high-speed motors and taking care to have them properly loaded has made it possible to maintain a power factor of over 70% even though most of the motors are 5 hp and less. Installation of two small capacitors has raised the power factor to above 80%.

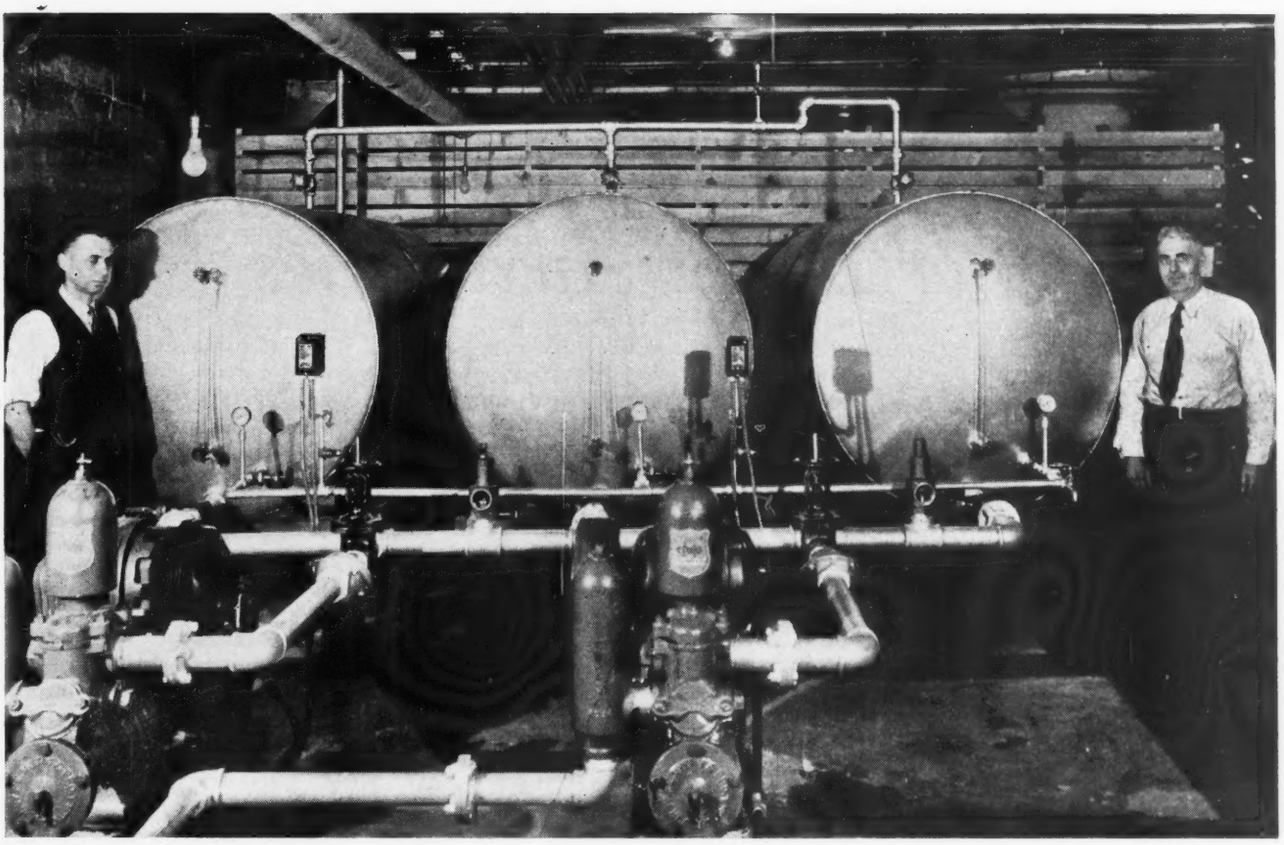
Most of the motors are geared to individual drives or group lineshafts. Exceptions are the machine and carpenter shops where flat-belt group drives are used. With the class of manufacturing machines used in this plant and kind of product produced, geared individual and group drives have proven the most satisfactory.

Motor Mountings

The motors are mounted on adjustable bases, which permits adjusting position of the motor to accommodate a larger or smaller pinion to change the speed of the driven machine when this is necessary. Machines geared to lineshafts are mounted so that if one of them jams it will be thrown out of gear to prevent damage.

All units are fused to protect against running under excessive overloads, either from single-phase operation or other causes. Exceptions to this are made where machines must run or the product will be ruined. Here, motors are fused to the safe limit of their connecting wires.

All electrical equipment is inspect-



A dug well, this pumping equipment and pressure-water system reduced purchased water nearly 2,000,000 cu ft per year

ed and cleaned once a week; lubrication of all ring-oiled bearings is checked at the same time. It is the purpose of these inspections to detect all faults or potential sources of trouble and correct them before they cause unexpected failures, prolonged breakdowns, expensive repairs and loss of production. The latter is generally the most expensive part of any power failure and by careful inspection it has been possible to eliminate almost all shutdowns.

Motor temperatures are watched closely and at the first signs of rise, the source of the trouble is looked for either in single-phase operation, overloads or other causes. Frequently, the maintenance staff has found that high motor temperatures are a warning that something is wrong with the driven machine and not the motor. Whatever the cause, it is located and corrected.

Replacement Program

Whenever a motor is suspected of being faulty, it is replaced by a spare and brought into the shop for a complete overhauling, cleaning, insulation-varnish treatment and new bearings if these are necessary. The reconditioned motor then becomes a spare.

If a machine operator complains about a motor running too slow, even though the motor speed is correct, no time is wasted trying to convince the operator of it—the motor is changed! The psychological effect is generally sufficient to keep the operator happy. This practice also works out well from a motor-maintenance standpoint as it provides a chance to recondition the motor taken out of service.

Motor Repairs

When a motor or a coil is to be rewound, it is sent to an outside repair shop. This simplifies the maintenance program, as rewinding facilities do not have to be provided. The rewinding is done by experienced men and a better job obtained than in a shop where only an occasional rewind is made. By careful inspection Mr Estlick has reduced rewinds to practically a negligible quantity. For example, last year only one motor had to be rewound at a cost of $40.00. This amounts to less than 6 cents per motor per year for outside repair service compared to 35.6 cents in 1918.

Also to simplify the maintenance set-up all piping installation over 4 in. in diameter is contracted for. There is not much of this work to be done in the plant and it does not pay to put in the equipment necessary to do it.

To check motor and circuit loadings the maintenance department has the following equipment: indicating polyphase wattmeter, a recording polyphase wattmeter, a voltmeter with a multiplier to give four voltage ranges of 0 to 150 to 600 volts. Two sets of current transformers are provided for the polyphase wattmeters, one for current ratios of 100, 50 and 25 to 5 amp, and the other for ratios of 40, 20 and 10 to 5 amp. Normally, the indicating wattmeter will give the necessary information, but when the performance of a machine is to be studied over a period, then the recorder is connected into the circuit. Other meters include tachometers, indicating and recording thermometers.

Maintenance Records

Records of operation and maintenance have been made simple to adapt them to the needs of the plant. Each motor is given an index card on which is recorded its nameplate data, where located and its service record. Yearly motor-maintenance costs are recorded on another card and a third card records yearly coal consumption, kwhrs used and water purchased. These form the permanent records of the operating department. In addition to the daily and monthly reports necessary for the yearly records, fire and safety reports are made weekly or every two weeks to the insurance companies.

DRAFT GAGES
For Boiler Auxiliaries

W H Pugsley, The Hays Corp, tells where to put draft gages for efficient operation of economizers, air heaters, dust collectors, and fans

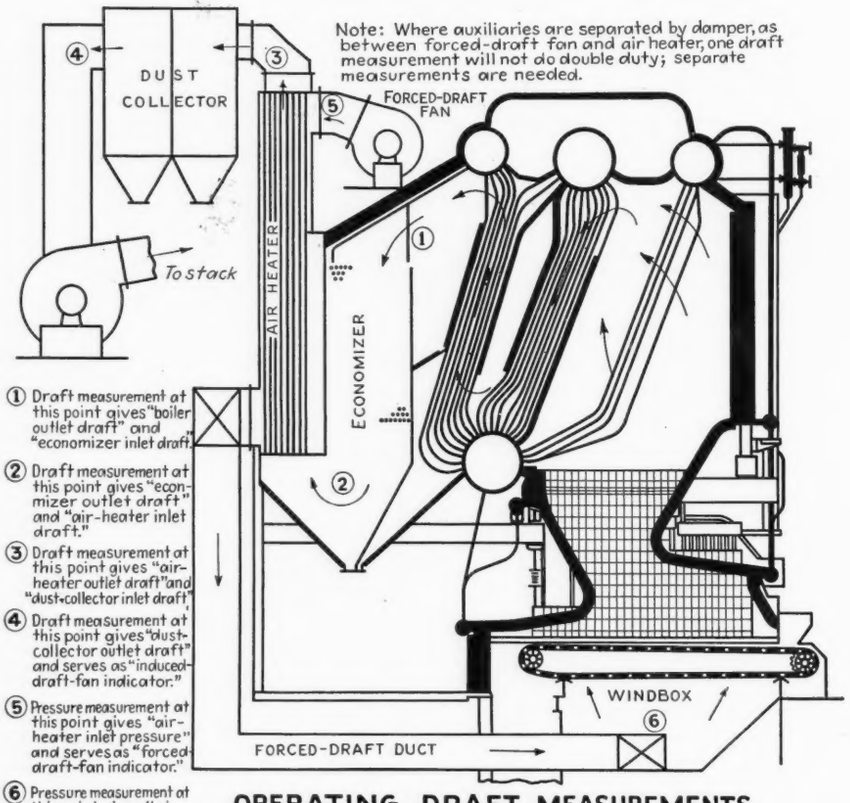
[A previous article, "How Many Draft Gages and Where" (POWER, October, 1940) outlined connections necessary for checking boiler and furnace conditions. This article gives similar information for boiler auxiliaries, and another will cover draft measurements for various types of firing equipment. —Ed.]

▶TWO DRAFT MEASUREMENTS are desirable for either an economizer, an air heater, or a dust collector. For test purposes, points of measurement are carefully located as close as possible to the point at which gas enters and leaves the heat-exchanger surface or dust-collecting device. This yields the true draft loss chargeable to the equipment without unfairly including loss in connecting ductwork.

Operating Measurements

For operating purposes, two measurements are also necessary but more latitude in locating the measuring points is possible. To reduce the number of draft-measuring points required, a single point may be made to do double duty. For example, when an economizer follows a boiler, a single measurement, taken near the boiler outlet, can be made to serve as "boiler-outlet draft" and as "economizer-inlet draft." Draft loss through connecting ductwork is considered as part of the economizer draft loss. The sketch shows how this combination of measuring points saves connections and expense on a steam-generating unit including economizer, air heater, and dust collector. If dampers are installed between individual auxiliaries, draft connections must be made on each side; a single connection won't do.

Draft loss through an economizer or an air heater varies nearly exactly as the square of the boiler rating. Thus, this draft loss can be used by the operator to check the air flow for combustion. Clogging of gas passages with soot or flyash causes a high resistance which shows up immediately as a higher draft loss, warning the operator that cleaning is required.


Note: Where auxiliaries are separated by damper, as between forced-draft fan and air heater, one draft measurement will not do double duty; separate measurements are needed.
DUST COLLECTOR
FORCED-DRAFT FAN
To stack
AIR HEATER
ECONOMIZER
WINDBOX
FORCED-DRAFT DUCT
① Draft measurement at this point gives "boiler outlet draft" and "economizer inlet draft."
② Draft measurement at this point gives "economizer outlet draft" and "air-heater inlet draft."
③ Draft measurement at this point gives "air-heater outlet draft" and "dust-collector inlet draft."
④ Draft measurement at this point gives "dust-collector outlet draft" and serves as "induced-draft-fan indicator."
⑤ Pressure measurement at this point gives "air-heater inlet pressure" and serves as "forced-draft-fan indicator."
⑥ Pressure measurement at this point gives "air-heater outlet pressure" and "windbox pressure"

OPERATING DRAFT MEASUREMENTS FOR BOILER AUXILIARIES

Because air heaters have two sets of gas passages, one for flue gas and one for air, they require an additional set of draft measurements. The "air-heater-inlet pressure" shows pressure of air delivered to the heater by the forced-draft fan. If no damper exists between fan and air heater, one indicator gives both "forced-draft-fan pressure" and "air-heater-inlet pressure."

Difference between "air-heater-inlet pressure" and "air-heater-outlet pressure" measures the pressure drop or loss through the air side of the heater. This loss also varies nearly as the square of the boiler rating and so may be used by the operator as a guide in controlling air supplied for combustion. If air from the heater discharges directly into a common windbox or plenum chamber, the "air-heater-outlet pressure" may serve as "windbox pressure" also. If there are several windboxes with dampers between them and the air-heater outlet, separate indicators are needed for each.

As in the case of draft measurements on the gas side, connections for test measurements on the air side must be made as close as possible to the heater inlet and outlet to measure loss of pressure across the heater only, and not in connecting ductwork. For operating purposes, this rule does not hold: for example, the inlet connection may be made at approximately the midpoint between fan outlet and heater inlet. Outlet pressure reading may be taken at the windbox, in which case pressure loss in the ductwork between air heater and windbox is considered as part of the loss of the air heater.

Differences Important

In operation it makes no difference which item of equipment includes the duct losses; the operator is primarily interested in changes in pressure or draft loss rather than in the absolute amount at any time. It is the *differences* in pressure or draft loss that act as a relative indicator of rate of flow of air or gas and as an indicator of the cleanliness and mechanical condition of the equipment.

Although referred to as a "draft" fan, the forced-draft fan establishes a pressure (positive, not negative) on the air to be used for combustion. Each fan should have a pressure connection to measure outlet pressure, whether the fan is constant-, variable-, or multi-speed. The pressure indicator shows whether the fan is running and the amount of pressure being maintained at a given volume of air delivery. This latter factor is important with variable or multi-speed fans. If there is no damper between fan outlet and windbox or air-heater inlet, an individual fan-pressure indicator is not necessary — the "windbox pressure" or "air-heater-inlet pressure" will serve the same purpose.

Where auxiliaries such as economizers, air heaters, and dust collectors form part of the steam-generating unit, induced-draft fans are usually needed to handle the extra draft loss involved. In such cases, the outlet-draft measurement on the piece of equipment preceding the fan will usually serve as a draft indicator for the fan, if no damper is installed between the preceding equipment and the fan. If there is a damper, or if for any other reason another draft connection cannot be made to serve, each induced-draft fan should be provided with an indicator to show the operator the amount of draft produced. This is especially important with variable- or multi-speed fans.

Connection for induced-draft indicators should be made on the periphery of the fan casing, as far from the rotor as possible. It should be placed away from the damper and the connection should be made parallel with the damper shaft so as to eliminate as much as possible the effect of damper movement on the reading secured.

Stack Draft

Whenever a stack is used to produce the draft for handling gas from the boiler, a stack-draft indicator will help the operator to determine if sufficient draft is being produced to handle the gas. It also assists in making manual adjustments to the boiler outlet damper, helping to determine the approximate change of opening required to compensate for differences in stack draft due to changes in weather conditions.

Q—Define boiler horsepower.

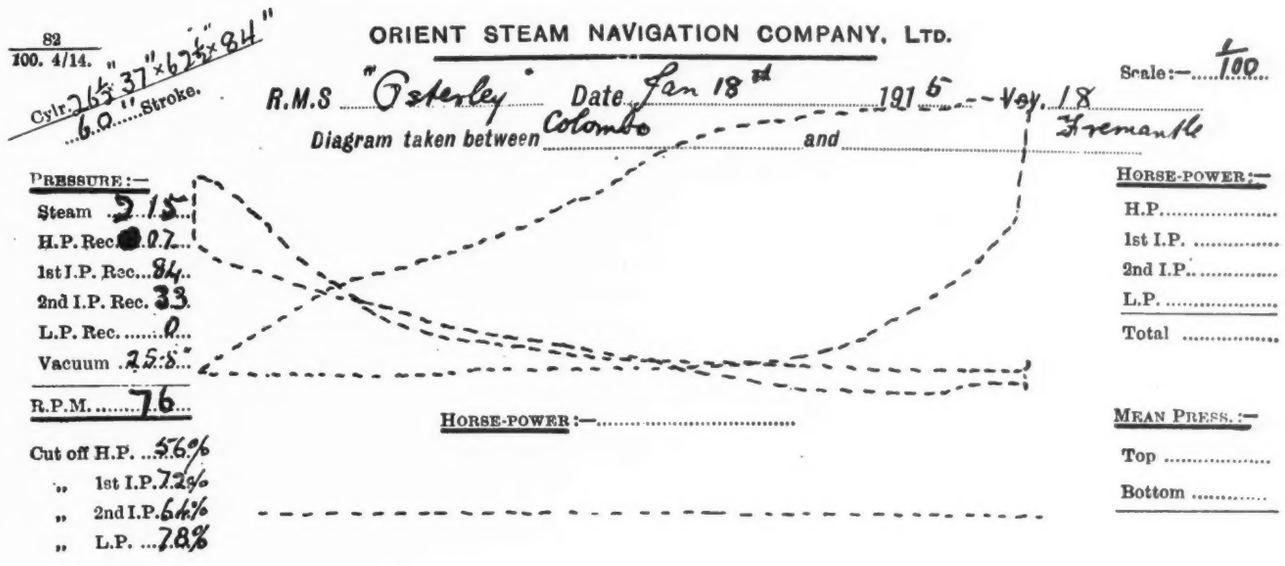
A—A boiler horsepower is taken as equal to the evaporation of 34.5 lb of water per hr, from and at 212 F.

✦ ✦ ✦

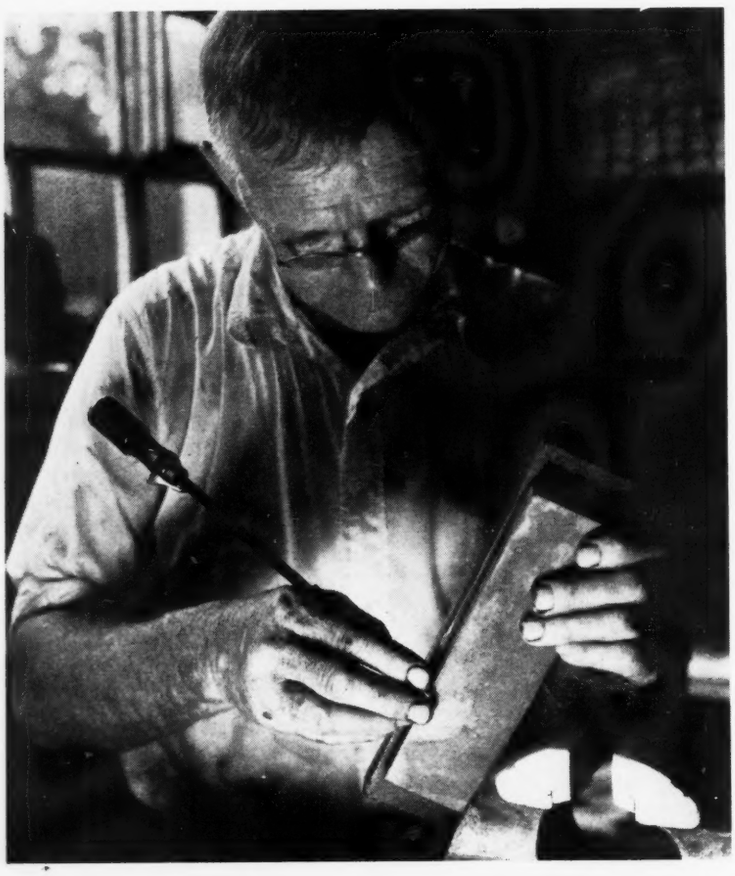
Can You Explain It?

► NOT LONG AGO, an engineer friend, sitting in POWER's offices chinning with the editors, hauled out the indicator card shown below and asked the assembled master minds to figure out what caused the somewhat peculiar shape. Between his hints and our wild guesses we pieced together the story. Now we put it up to our readers—explain how the card got that way!

The illustration is an exact reproduction of the original; the pencil lines were inked for clarity. Here are a few hints: there isn't anything seriously wrong with the engine or the valve setting, and it isn't a joke or a phony. Remember also that the card was taken on shipboard—that's the real key to the mystery. We're not giving any prizes for answers, but we'll publish any good ones.



PRACTICAL AIDS TO OPERATION



How to Sharpen Glass Cutters

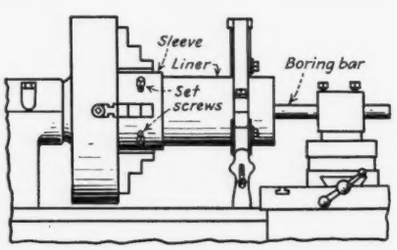
MOST ENGINEERS probably believe that an ordinary glass cutter is too hard to be sharpened on an oil stone, and struggle along with it dull. But, just try it some time and you will find that it can be done easily. Hold the bevel of the cutter against the stone so that pressure comes onto the cutter edge. Then move the cutter back and forth over the surface of the stone. When this is done on each side of the cutter for a few minutes it will be found that its cutting qualities have been greatly improved. The photo shows a gage glass cutter being sharpened on the side of an oil stone.

Riverdale, N. Y. ALEX GRAY
Chief Engineer, Colored Orphan Asylum

Pump-Cylinder Liners Trued in a Lathe

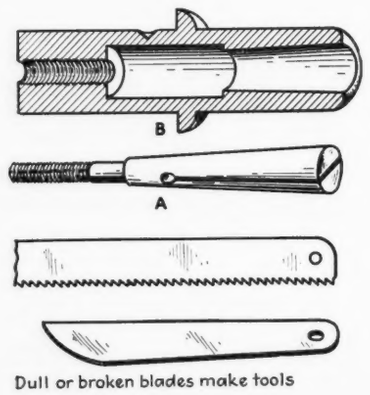
WHEN YOU OPERATE A PLANT in a remote corner of the world your resourcefulness is your best friend. On one occasion a pump cylinder's liners were badly scored. It would have required several weeks to obtain new ones. We had a lathe and decided to remove the old liners and rebore them.

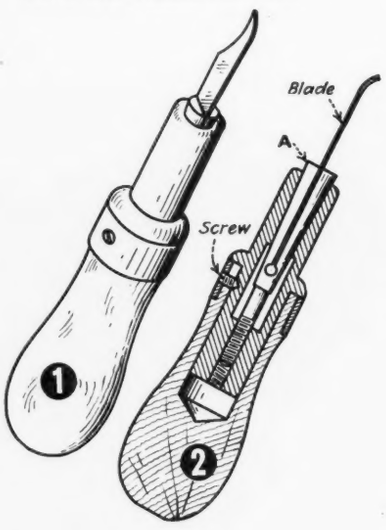
To prevent the lathe chuck distorting the liners we made a sleeve from a piece of pipe that the liners would fit into snugly. Three equally spaced holes were bored and tapped around the circumference of the sleeve and shallow recesses were made in the liners for the ends of the setscrews. These permitted the liners to be held from turning in the sleeve with only light pressure from the screws. A liner with the sleeve in place was then set up in the lathe, as shown in the figure, with its free end in the steady rest.



Great care was taken to make sure that the liner ran true in the lathe before starting to true its inside. Very light cuts were taken until the inside surface was made true. After doing some doctoring on the pistons the pump was assembled and went back into service practically as good as new.

New York, N. Y. S M ELONKA





Quick-Change Handle for Blade Tools

HAVING CONSIDERABLE USE for small-bladed tools, I designed a special handle, Figs. 1 and 2. The small tools I made from pieces of power hack-saw blades. The handle consists of three parts: the tapered split blade holder

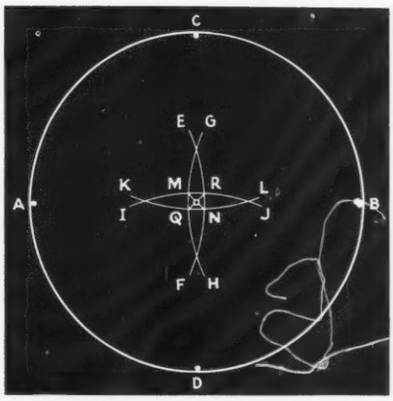
with a threaded end as shown at *A*, the hollow tapered sleeve *B* threaded to receive the blade holder, and a hard wood handle with ferrule, into which the sleeve is secured with screws.

The sectional view of the tool, Fig. 2, shows how the tool is held in the handle. By holding the blade and turning the handle, blades are easily tightened or loosened.

Penacook, N. H. CHAS H WILLEY

How to Find Center of a Circular Plate

PLANT ENGINEERS sometimes have to locate the center of circular flange plates, flanged heads, or other circular parts.



An accurate easy method is one used by many boiler makers in layout work. A piece of chalk and a string are the only tools necessary, although a chalk compass may be a little more convenient and accurate. At any place on the disk circumference use point *A* as a center for arc *EF*, the radius of which should be slightly greater than the radius of the disk. This may be determined quickly by trial, as when using *B* as center, at a point approximately diametrically opposite *A*, arc *GH* should overlap arc *EF* slightly.

Then, using *C* and *D* as centers approximately half way between *A* and *B* draw arc *LK* and *IJ*. Diagonally opposite points of the arc intersections are then connected by chalk lines, as shown by lines *QR* and *MN*. The intersection of these two lines at point *O* may be center punched as the exact center of the disk.

Canton, Mass. HARRY M SPRING

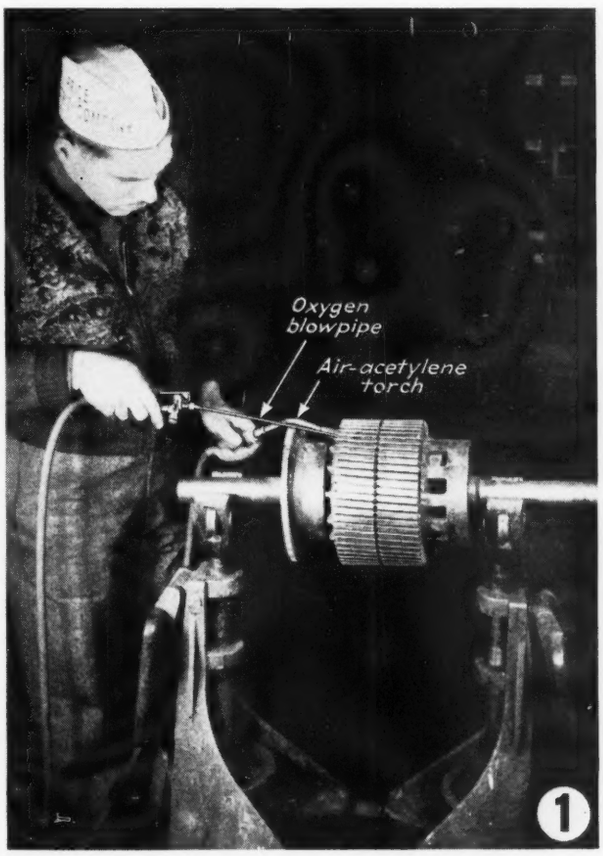
Blowpipe Removes Armature Insulation

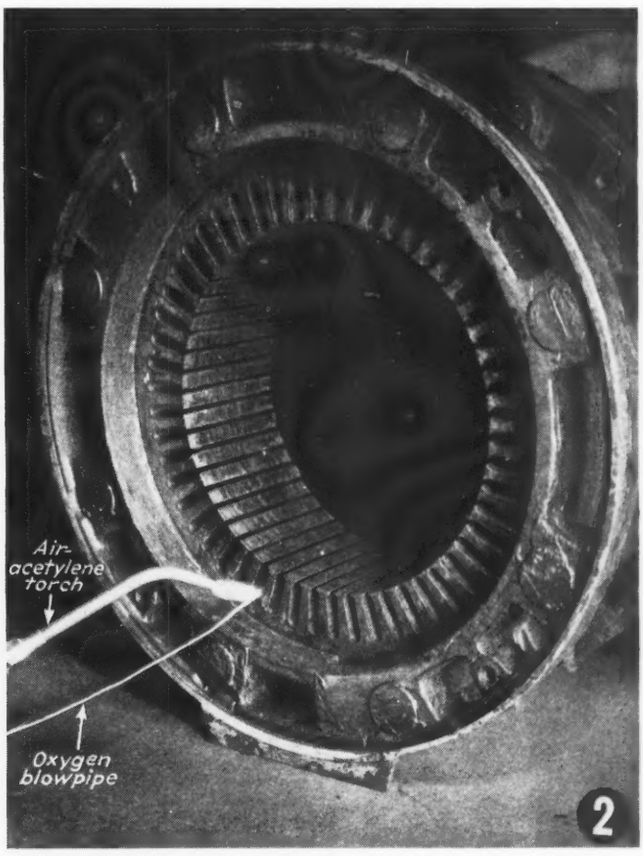
AFTER A WINDING is removed from an armature or a stator core, much of the old insulation remains in the slots. Before the new winding can be put into place all the old insulation must be carefully removed by scrapers and motor-driven sanding wheels. At best this is a slow and disagreeable job that may require several hours to complete.

Looking for a means of speeding up this work, one shop developed a system of burning off the insulation. Now, after the armature or stator has been stripped of its windings, combustion of the slot insulation is started with the flame from an air-acetylene torch. Then, a stream of oxygen, directed from a decarbonizing blowpipe, hastens burning of the insulation along the slot.

The decarbonizing blowpipe is moved slowly from one end of the slot to the other as the insulation burns. Oxygen is supplied through a ¼-in. hose at a pressure of 3 lb per sq in. Fig. 1 shows this method being applied to a direct-current armature core and Fig. 2 to an induction-motor stator core.

Burning of the insulation is so complete that no additional cleaning of the slots is necessary, except to brush out



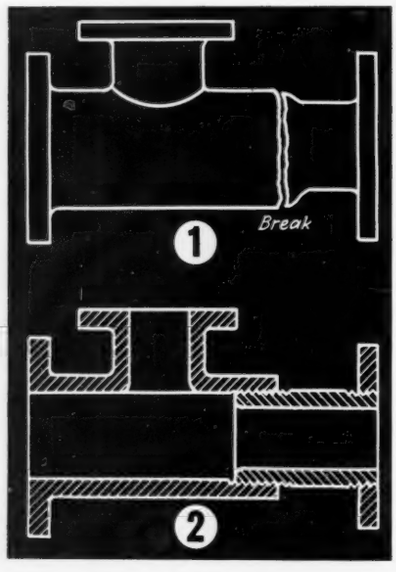


the loose ashes. Jobs that previously required several hours to do by scraping can now be completed in 30 min or less. On some large motors a heavily oxidizing flame, produced by a standard welding blowpipe with a small tip, also works satisfactorily.

Cleveland, Ohio D C Olson
The Linde Air Products Co

Quick Repair for Broken Pipe Tee

Before the days when welding was used as generally as it is now a cast-iron pipe tee cracked, see Fig. 1. A new one could not be obtained for several days and a repair job was attempted. We set the large part of the tee in our lathe, cut off the small section and cut a thread inside this end of the tee. A piece of pipe was then threaded into the tee and cut off to give the tee its original over-all length. We



threaded the free end of the pipe for a flange, which we cut from the broken part of the tee and threaded it to fit the pipe. The completed job looked like Fig. 2.

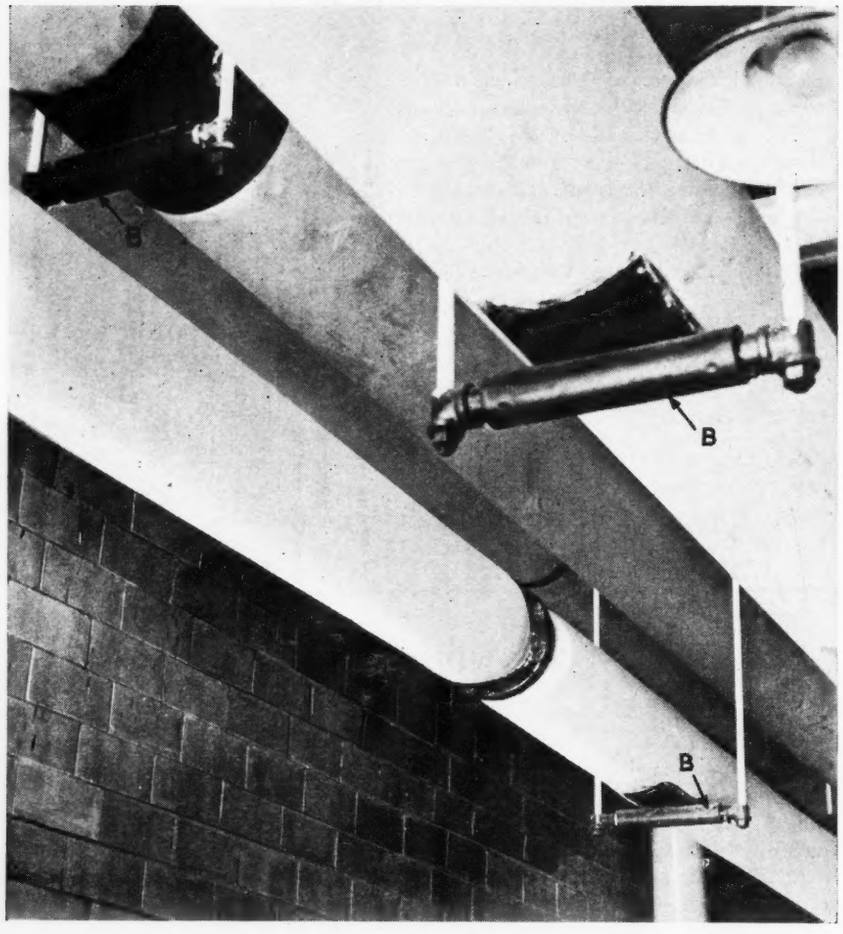
New York, N. Y. E M Elonka

Why AC Magnet Coils May Overheat

Alternating-current electromagnets differ from direct-current designs in several ways. Some of these cause heating of the former when dc units would not be affected. First, the current through a dc magnet coil is limited by the resistance of its circuit. In an alternating-current magnet coil the current is limited by the resistance and inductance or, as it is called, the reactance of the circuit.

These magnets are also so designed that their armature fits onto the magnet core to form a complete iron loop when the magnet is closed. If dirt gets between the armature and the magnet core faces it will produce a small air gap and reduce the magnetic flux through the core. This in turn will decrease the inductance and increase the current in the coil. I have found this condition will cause magnetic coils to seriously overheat or burn out. Therefore, when inspecting alternating-current magnets, care must be taken to insure that the faces of the armature and magnetic core are perfectly clean and in good alignment.

When an alternating-current electromagnet is open it has a large air gap between the armature and magnet core. This causes the inductance of the coil to be low and the inrush current high. If the magnet operates infrequently the inrush current does not overheat the



Roller Bearing Supports Pipeline

Many methods are used to permit pipes, carrying hot water or steam, to move freely in their supports to eliminate stresses due to expansion and contraction with change of temperature. The American Viscose Corp at its Front Royal, Va., plant has solved this problem on long hot-water lines by supporting them on tapered roller bearings. Steam lines in the company's Nitro, W. Va., plant are also supported in that way. Bearing mountings consist of a steel tube B (see photo) 8 in. long, equipped with a roller bearing at each end. Each bearing has an inner and outer seal and is grease lubricated.

These are believed to be the first application of this type of pipe hanger. The ease with which the rollers can turn permits pipe expansion and contraction to take place without excessive stresses in the pipe or hangers.

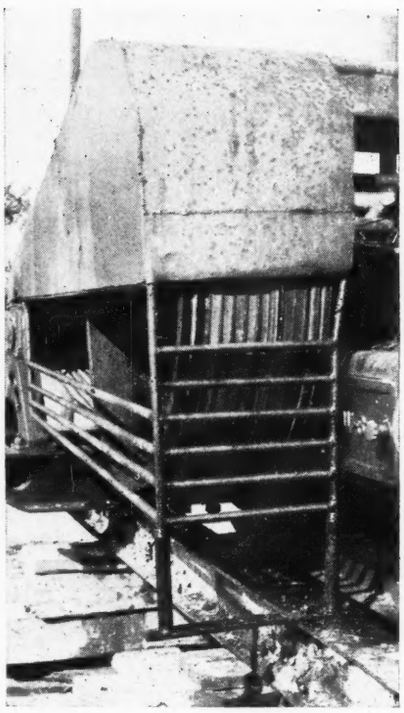
Canton, Ohio S L Huffman
Timken Roller Bearing Co

coil, because it has a chance to cool off between operations. On the other hand, if a coil that is designed to close the magnet a few times a day is used for frequent operation, the accumulated effects of the inrush current may overheat the coil.

If, for any reason, the magnet cannot close when the coil is energized, current in the coil will remain at inrush values and it will burn out in a short time if left connected to the line.

A few turns short circuited in a direct-current magnet coil will have practically no effect. On an alternating-current magnet coil, short-circuited turns act as a closed secondary on a transformer and a heavy reverse current flows in them to demagnetize the core and increase the current in the part of the coil in the circuit to where it will soon burn out, if left connected to the power supply.

Oakland, Calif. R B GLENN



Easily Made Guard Protects V-Belts

EXPOSED V-BELT DRIVES suffer more from accidental injury than from normal wear. The photo shows a guard we use to shield the belts from weather and accidental injury. It is formed from welded sheet steel over the entire upper half of the drive, with closely spaced bars to prevent accidental contact with the lower half of the belts, by attendants and others who may happen to be near the belts.

The guard gives ample protection and permits inspection of the belts while in operation. Extended corners of the guard frame, resting in sockets supported on the power unit, permit the entire guard to be lifted free for replacement of a belt or other maintenance work.

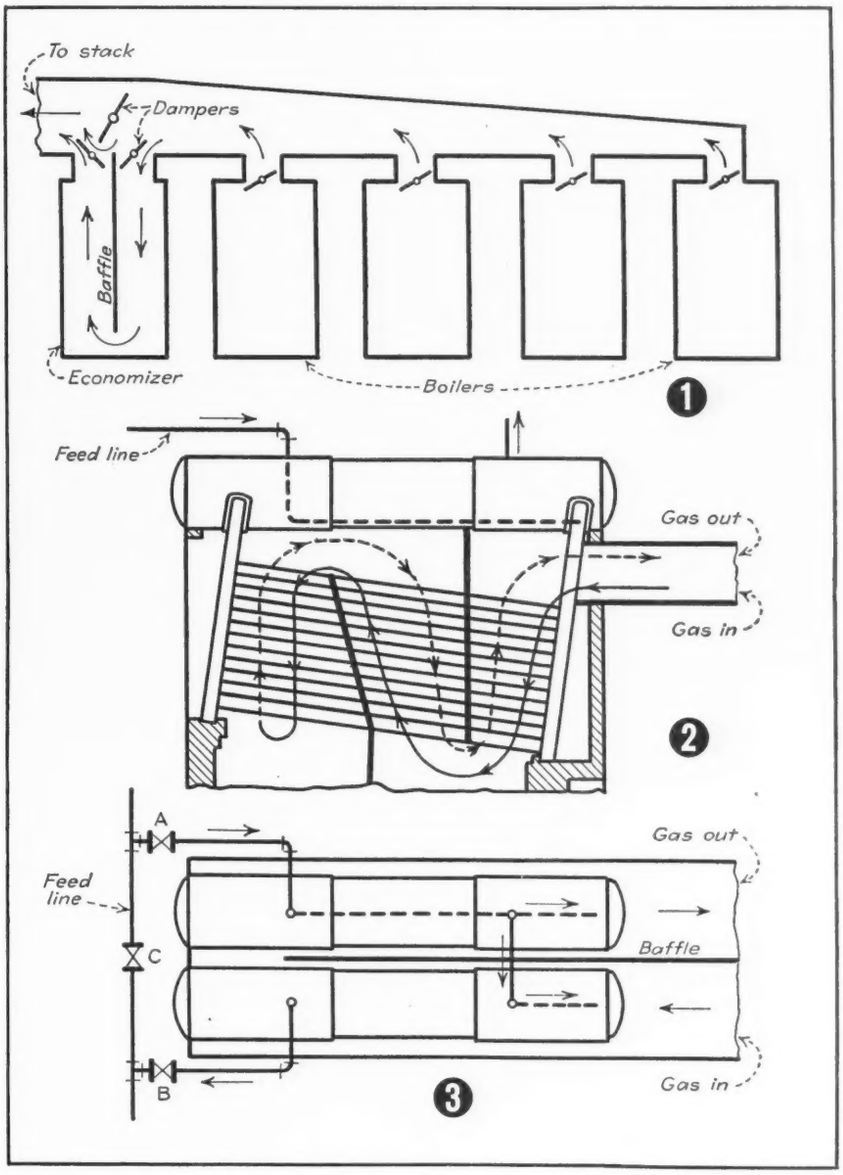
Houston, Texas M T PATE

Boiler Converted Into an Economizer

IN A POWER PLANT having five boilers installed, but never using more than three of them at any one time, the engineer decided to use the one nearest the stack as an economizer, Fig. 1. The boilers are double-longitudinal-drum units with vertical baffles, as in Fig. 2. To change the boiler to an economizer, the original baffles were left in place but a vertical longitudinal baffle was also added. Figs. 1 and 3. Tubes were removed in the center of the boiler to install this baffle. Other changes included a damper in the breeching and one in the gas inlet and outlet of the economizer.

Feedwater connections were made to the drums as indicated in Figs. 2 and 3. Inlet connections go down to the bottom of the drums and are piped to their rear ends, as indicated. Valves *A*, *B* and *C* and the dampers permit cutting the economizer into and out of circuit. In passing through the economizer the gas temperature drops 180 F during normal operation and feedwater temperature increases 50 F. Normally, only about 25% of the flue gas from the three boilers is bypassed through the economizer. This change saves about $1500 per year in the coal bill and the cost of making it was about $500.

Oak Park, Ill. N T PEF



READERS' PROBLEMS

Questions from Our Readers

Pump for Cooler

Question 1

IN OUR PLANT, *water, under 15-lb pressure, passes through a double-pipe cooler (2 sections, 12 stands high) and then flows to the sewer through a 2-in. pipe. We want to save this water by pumping it to a water tank 40 ft above. The pumping unit we intend to use on the job is a centrifugal with 2-in. inlet and outlet, driven by a 5-hp motor, at 1720 rpm. The question is: will the pump handle this flow under these conditions, will it hinder in any way flow through the cooler, and what is the best layout for pump and piping?*—JPC

Smoke Troubles

Question 2

WE HAVE ONE *516-hp Erie boiler with a 5-retort Taylor stoker and two 250-hp McNaulls, with old-style shaft-driven Taylor stokers. One of these latter had an air back installed recently. The draft system includes a 150-ft stack and forced-draft fan. We burn all classes of coal supplied by the railroad system serving our plant. On the two small boilers we have trouble with occasional spells of smoking, that is, they will smoke for several hours at a time and then stop. This will happen on the same car of coal and under the same conditions. We keep retorts free of clinker, adjust thickness of fires to size of coal. Stack draft is good, tubes are deslagged and gas passages clean. We can reduce draft but the smoking still occurs. My only solution is that our bricklayer keeps building out the sidewalls in making brickwork repairs. Can any* POWER *readers suggest reasons for this smoke difficulty?*—LT

SUITABLE ANSWERS from readers will be paid for if space is available for publication. Answers accompanied by practical drawings or photographs will command additional pay.

Orifice in Gage Glass

Answers to Nov Question 1

The Question

WE USE A *½x16-in. Pyrex gage glass and a safety glass on each boiler. In the lower shutoff cock we use a thin disk with a ⅛-in. hole in the center, thus forming an orifice in the end of the gage glass. This arrangement adds considerably to the life of the glass. We would like to have the opinion of* POWER *readers regarding possible operating or safety disadvantages of this scheme*—JBC

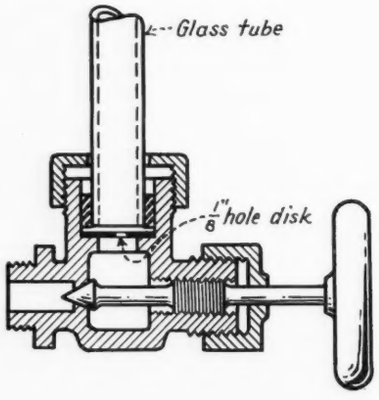
Obstructed Flow Is Dangerous

JBC SAYS HE HAS INCREASED life of boiler gage glasses by inserting a ⅛-in. orifice disk in the ½-in. opening. This probably results from a decrease in total pressure in the glass. The area of ⅛- and ½-in. openings are respectively 0.01227 and 0.19635 sq in. Therefore, the effective area at the bottom has been reduced nearly 94%.

In reducing the effective area of the bottom opening, JBC reduces the flow capacity proportionately. In consequence, it is possible he may not obtain a true reading of the boiler water level. Certain it is that any sudden change in water level would not reflect as quickly and the chance that sediment may block off the tiny ⅛-in. orifice is greatly enhanced.

It stands to reason that a small piece of scale that would pass through the ¼-in. opening may be caught and block passage of water in the smaller opening. I have seen ½-in. gage glasses completely choked off by an accumulation of scale and I feel that a ⅛-in. orifice is not only a hazard to safe operation but unreliable as well.

New York, N. Y. W S DOWNS



Believes Orifice OK

USING A DISK with a ⅛-in. hole on the lower leg of the gage glass should not offer any disadvantage from the operating or the safety angle since the ⅛-in. hole is big enough for needed flow. Frequency of gage-line stoppage will probably increase because sediment and mud settling will stop a small passage sooner than a large one, but this also has its good side.

In my experience, several times when the gage line was stopped it was necessary to remove the entire line from the gage to the boiler to find the point of stoppage. This is a considerable job. With an orifice in the line, the stoppage in most cases will be at this point and the operator will know exactly where to look. I assume the disk is installed on the gage side of the shutoff valve, as it should be, and provisions made for its easy removal.

On some boilers there are valves on the water-column lines and in such case the disk may be installed on the boiler side of the gage-glass shutoff valve. I would not recommend using a disk unless provision is made for removal in service.

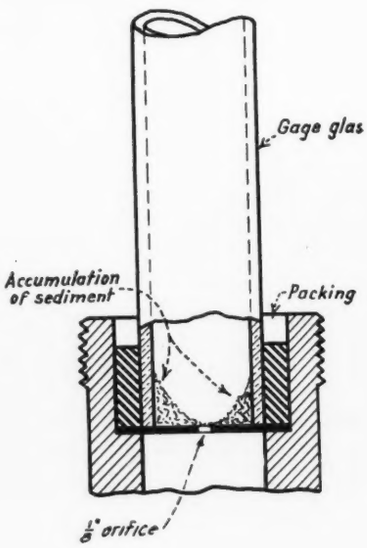
JBC states that the disk is in the shutoff cock but does not say whether it is on the boiler side of the seat or on the gage side. If on the gage side, as it should be, I cannot think of any better place than right under the glass tube. The sketch shows a gage-glass shutoff valve and the disk location.

I am not convinced that JBC has solved the problem of gage-glass breakage, although the orifice may help. In my experience, gage-glass breakage was never a problem and only at rare intervals have they broken. High loss of glasses might be due to other causes and the better results with the orifice only a coincidence. If JBC will try using disks on some boilers and not on others, he may be able to prove that the gain is due to the disk.

Chicago, Ill. N T PEF

Not Worth Risk

JBC'S ARRANGEMENT may show a small profit in saving gage glasses but it isn't worth the chance should the glass give a false reading, which is more than likely to happen when the area at the bottom is reduced. The sediment in untreated feedwater will plug the orifice in time; even with treated water there will be a tendency to plug. Should oil ever show



in the glass, as it will when even a small amount gets into the boiler, then when the gage glass is blown down a certain amount of this oil and sediment will adhere to the disk and after several blowdowns the orifice will be plugged. The dotted lines on the sketch show how it is possible for sediment or scale to build up gradually and in such a way as to be impossible to detect from the boiler-room floor.

If I were in JBC's position, I would pass up the small saving possible, for peace of mind—no trouble may come from plugging of the orifice but the possibility is there.

Philadelphia, Pa. W T MULLEN

Orifice Poor Practice

I BELIEVE it is poor practice to obstruct the end of a gage glass. JBC may add somewhat to the life of the glass by doing so, but it is a hazardous practice and does not conform with safety rules, as scale or foreign matter might close the ¼-in. hole and the gage would not show true water level. I am surprised that the inspectors, if they know it, let JBC get by with this procedure.

JBC might turn glasses bottom side up and get longer service from glasses, as the bottom end wears more rapidly than the top end. However, I would not even recommend this practice. I install new gage glasses at the beginning of every season.

Evansville, Ind. LESLIE ARMSTRONG

Don't Use Orifice

UNDER NO CIRCUMSTANCES would I recommend installation of an orifice in any boiler gage-glass connection. There is no comparison between the cost of a gage glass and a damaged boiler. Any small piece of scale, rust, glass or gasket material could easily close the small ¼-in. orifice. Since there is a small flow of water downward through the gage glass, any obstruction or partial obstruction would result in a water-level reading higher than that actually existing in the boiler or column. Just try shutting off the lower gage-glass connection for a few minutes and see what happens to the level in the glass!

Most glasses, and especially Pyrex glasses, stand a lot of abuse provided they are installed properly. This means proper alignment, correct length, correct gaskets and washers, and last but not least, correct assembly. Meeting all these requirements results in longer glass life.

Rittman, Ohio U J GRANT

Breakage of Wedge Bolt

Answers to Nov Question 2

The Question

WE HAVE BEEN TROUBLED *by the breaking of the top wedge bolt for adjusting the crankpin brasses of the connecting rod of our Corliss engine. The connecting rod has a solid end with a bolt in the upper and lower ends of the adjustable wedge. The top bolt has broken several times just under the head and once or twice about where it enters the wedge. What is the remedy?*—AAF

Bolt Hole Too Tight?

WE HAD TROUBLE similar to AAF's on two Erie City engines. We found, on examining the connecting rod, an opening between the back of the wedge and the solid end of the connecting rod. This was caused by the bolt hole being too tight. Reaming the bolt hole overcame this trouble. Under these conditions, if the wedge is up the break will be at the bolt head and if the wedge is down the bolt will break at the wedge.

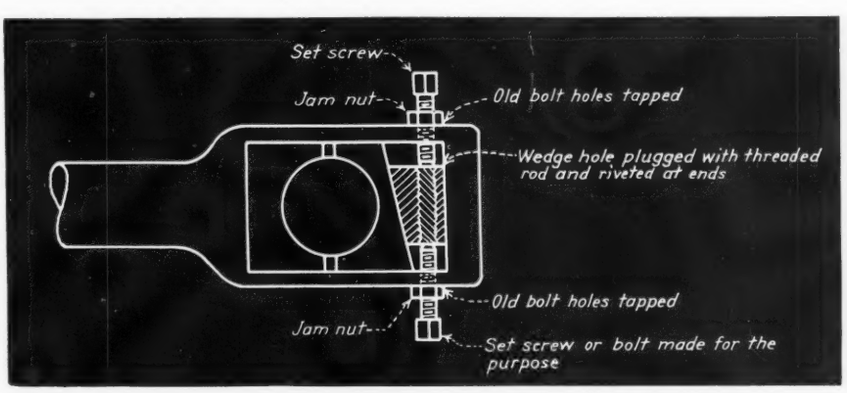
Baltimore, Md. F WIECHMANN

Try New Arrangement

BREAKAGE OF AAF'S WEDGE BOLTS could be caused by the hole in the wedge not being drilled or tapped in line, by the hole in the rod being out of line, or the wedge block could be worn at the end next to the rod. Any of these conditions would cause the wedge block to be held slightly away from the end of the connecting rod, causing the bolts to be sprung slightly. The wedge bolts might be too weak, in which case they could be made larger, or, better still, bolts made from SAE axle steel could be substituted. A single straight threaded bolt running through both rod and wedge, with two nuts on the end, could be made of this material and would probably give good service.

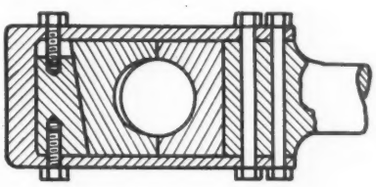
If the rod end has clearance enough in the crankpit, breakage can be stopped by the method illustrated in the sketch. This adjusting scheme allows for any slight movement which might occur. I have never seen any trouble where this scheme is used.

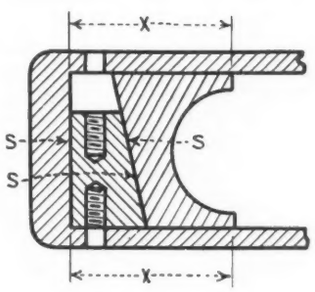
Sayre, Okla. G M HARDY


Set screw
Jam nut
Old bolt holes tapped
Wedge hole plugged with threaded rod and riveted at ends
Old bolt holes tapped
Jam nut
Set screw or bolt made for the purpose

Is Alignment OK?

THERE ARE MANY POSSIBLE ANSWERS to AAF's question, but a good way to start would be to check alignment of the crank itself and also of the shaft. This looks more possible as a cause of the trouble than wear of the brasses, which if worn enough to come together, as shown in the





sketch, would cause a noticeable knock and AAF mentions none. A condition of this kind would give the brass a sharp rap at every turn of the shaft.

AAF should also check the surfaces and distances as shown in the second sketch—the marked distances should be equal. If not, the surfaces *S* are not true or are worn. Discrepancies at these points would strain the top bolt, causing breakage.

Chicago, Ill. G A HEINZE

Check Bolt Alignment

I SUGGEST that AAF check the alignment of the holes in the top and bottom of the connecting rod with the threaded hole in the wedge, being careful to see that the wedge is firmly against the stub end of the rod. If these holes do not line up properly, when the bolts are tightened they will tend to pull the wedge away from the end of the rod.

When steam is admitted to the cylinder, the rod is pushed forward bringing the wedge and box against the pin, with the strain being taken up by the wedge resting firmly against the end of the rod. If, however, the wedge is pulled away from

the end of the rod by the bolts, then the strain is taken up by the bolts and the bolts are subjected to shearing forces. This continued action will eventually break the bolts.

Waterbury, Conn. F W CARTER

Crankpin May Be Out of Line

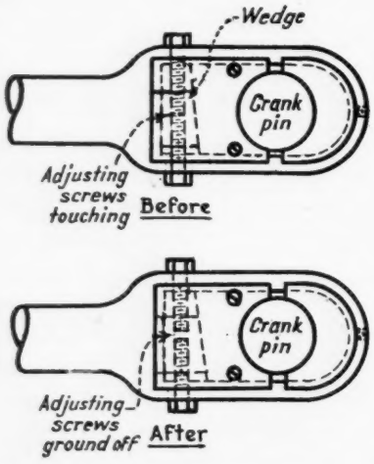
THE FIRST POSSIBLE DEFECT to consider is misalignment of the crankpin. Crankpins are subject to this condition after a time, particularly under variable-load operation or vibration conditions. If this part is off center or out-of-round, the best remedy lies in replacing the pin, first checking alignment of the crankpin bore and the shaft. It might also be wise to inspect the shaft itself. While it seems that this part should be free of defects, a periodical inspection for scored journals and for fractures at the junction with the crank arm is often justified.

If the crankpin is satisfactory, brasses should be checked for excessive wear. It is quite possible that they are so worn as to make it impossible to adjust them to keep the journal steady. If this is the condition, the steps should be removed and replaced, otherwise pounding of brasses on the crankpin would cause wedge-bolt failure. Lining the bearing with brasses is intended to extend the life. It may be found that brasses are in good condition but the bearing they line is worn excessively either through long usage or improper lubrication. This possibility should be checked.

New York, N. Y. BRIAN CORRIGAN

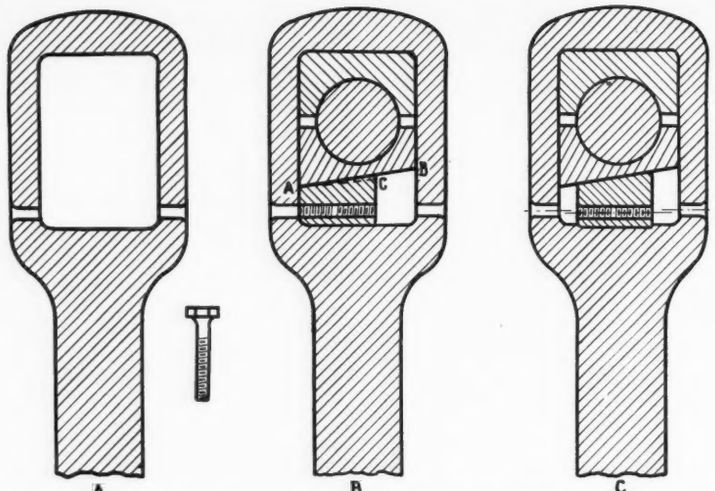
Check Bolt Clearance

A FEW YEARS AGO, we had trouble similar to AAF's on a Fitchburg engine at our plant. In checking the wedge and wedge bolts after several had broken, we found that the bolts touched as shown in the



sketch. To remedy this condition we ground off the bolt ends and fitted them as shown in the lower part of the sketch. Since this was done there has been no breakage trouble.

Bennington, Vt. G A SPENCER


A
B
C
A
Note fillet under head of bolt and corresponding fillet in rod
B
Taper on brass and wedge should correspond along solid line A B
Taper on wedge along line A C would give trouble
C
Worn rod allows wedge to get out of line with bolt holes in rod

Six Causes of Breakage

TROUBLE EXPERIENCED by breakage of top wedge bolts has been found to result from one or more of the following six causes: (1) First and foremost, not keeping engine properly keyed up, allowing the wedge to be hammered. (2) Square corners between head and body of bolt. The proper correction for this lies in allowing a generous fillet between head and body and in rounding off corners of the strap holes to allow for this fillet (see inset in sketch below). (3) Incorrect taper on either wedge or brass. If tapers are not similar, full surface contact will not be secured and there will be a tendency for the wedge to rock (see *B* in sketch).

(4) Wear of connecting-rod-eye end or of wedge which permits bolt hole in wedge to get out of line with corresponding hole in top and bottom of connecting rod. It should be possible at any position of wedge to enter top and bottom wedge bolts freely in the wedge (see *C* in sketch). (5) Using hammer or sledge on top of wedge to drive down wedge to take up slack after keying up. Pulling down the wedge with the bottom bolt eliminates the hazard of this practice. (6) Use of medium-carbon steel of high ductility has been found to give best results.

Breakage trouble has been satisfactorily corrected, especially in big engines, by replacing vertical with horizontal wedges.

Pittsburgh, Pa. C J WYROUGH

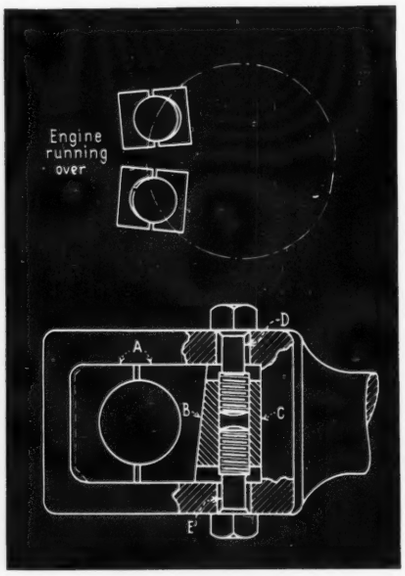
Several Remedies

ABOUT TWO YEARS AGO, we had trouble with wedge-bolt breakage on a large steam-driven vacuum pump; the thoughts and sketches below result from our efforts to solve this problem. Improper valve setting will cause strains when a reversal of pressure occurs, as there must always be some lost motion at the crankpin brasses. The sketch shows this in exaggerated fashion.

If the brasses and wedge are not fitted snug in the connecting rod, there will be a heavy strain on the bolts during pressure reversal, but if the engine has the right amount of compression the lost motion will be transferred gently from one side to the other, before the crank reaches dead center.

Loose brasses and wedges can be overcome by placing a liner at *A* in the lower sketch, and then scraping the brasses to a tapping fit in the connecting rod. The wedges should be bedded with red lead to bear evenly on the two faces *B* and *C*. The elongated holes should be inspected to be sure there is clearance when the wedge is in place as there have been cases when one bolt has carried a strain at *D* and the other at *E*. We made our bolts from steel of an old car axle, and left a small fillet near the head, as shown on the sketch. The bolt hole in the rod was also chamfered to suit the fillet, doing away with the sharp corners likely to weaken the bolt.

Goderick, Ontario G BARRETT



Bolts Not Big Enough?

I HAVE FOUND that connecting-rod-bolt breakage may be traced to: (1) too much lost motion which causes pounding, stretching and strains on the bolt, (2) poor fit of bolt in hole through rod, and (3) improper design of bolt, particularly failure to make bolt large enough to stand regular working strains.

Some years ago I worked on several Watertown engines, direct-connected to dc generators. These engines ran about 440 hp in capacity and were of several types, including tandem, cross-compound, slide valve, and 4-valve. All were shaft governed and ran at medium speed. During a period of several years these engines broke many connecting-rod wedge bolts.

Different grades of steel and even Swedish iron were used as bolt material with no perceptible difference. It was found that if these bolts were permitted to run slack, a click would develop followed by breakage. The bolt size was $\frac{7}{8}$-in. in all cases. On one of the engines, we reamed the rod holes to 1-in. and fitted wedges for the larger bolt size. The change brought a reduction in breakage.

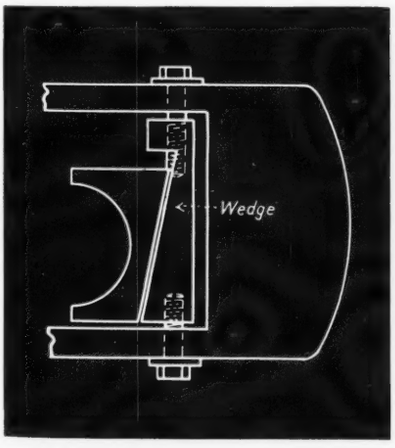
At present I am running two Harrisburg engines of practically the same capacity as those above, also high-speed (185 rpm) shaft-governed machines directly connected to dc generators. All connecting-rod wedge bolts in these engines are $1\frac{1}{8}$ in. diameter. Occasional bolt breakage on these machines can be attributed to running with boxes keyed too slack, over a considerable period of time. On another Harrisburg engine (125-hp, 225-rpm, shaft-governed) we have had satisfactory experience with $\frac{7}{8}$-in. bolts, following factory design.

New York, N. Y. C G MANDEVILLE

Check Bolt Length

WE HAVE THE SAME TROUBLE as AAF and the only remedy found successful is to key up brasses at regular intervals and not allow bearings to run loose at any time. We decided that it must be the working of the loose bearing box on the wedge that was breaking the bolt as the pressure was down on the wedge and it was the top bolt that broke, almost invariably. As we broke more bolts in summer than in winter, someone thought that heat must play an important part in the fracture. Thus, we drilled holes lengthwise in the bolts to allow for air circulation to dissipate heat. This didn't stop breakage and the idea was abandoned.

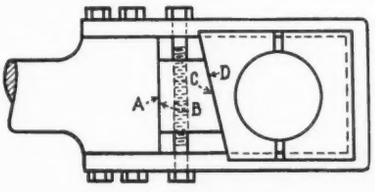
We had one unusual condition on a 175-hp Corliss that might give AAF a clue to his trouble. A slight knock showed up in the high-pressure crank and wedge bolts broke. All bearings proved tight but the knock persisted. After a few bolts had broken, the foreman had the worn bearing removed and found that the wedge bolt was too long, hitting the edge of the bearing and preventing true tightening of the wedge, even though it felt tight. Sawing off the wedge bolt cured the trouble. The sketch shows the condition, somewhat exaggerated.



Duluth, Minn. HAROLD RUSHENBERG

Bolts Out of Line

AAF's TROUBLE lies in poor alignment of the wedge bolts with the strap holes due to wear of the wedge or of the surfaces it bears against. For simplicity, the sketch shows a bearing assembly with bolted-on strap. Examine surfaces *A*, *B*, *C*, and *D*. If smooth, with no shoulders on *A* or *D*, a shim can be placed between surfaces *A* and *B*, of sufficient thickness to bring the wedge bolts central with the strap holes. The permanent remedy is to



file or machine surfaces *A* and *D* perfectly flat and true and to make a new wedge with the tapped hole perfectly in line with the wedge-bolt holes.

If the connecting rod is of the Nordberg type, with a cylindrical wedge, it can also be temporarily remedied by placing a small shim in front of the wedge or the holes in the wedge-bolt washers can be filed off center to give the bolts clearance all around. If any appreciable changes have been made, it would be well to ascertain the piston clearance before starting up.

Milwaukee, Wis. L M LARSON

Keep Bearings Snug

I AM CONVINCED the basic trouble lies in allowing too much clearance between bearing and crankpin. There is, of course, a minimum and maximum allowable clearance for safe operation but there is a tendency among operating engineers to allow a loose bearing to run "just a little longer". This looseness allows the brasses to work in the strap and as time goes on the surface of the brass fitting against the inside of the strap will show wear. The more wear, the greater the movement.

Movement of the brass throws a force against the wedge, first at the bottom and then at the top, or vice versa, depending on the direction of rotation. The rocking motion of the brass and the wedge causes the wedge bolts to bend back and forth, with eventual fatigue failure. The point of breakage is usually where the bolt enters the wedge or where the bolt shank enters the head.

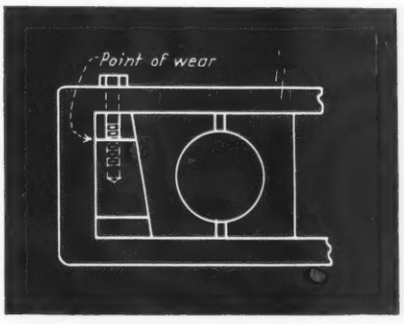
I recommend that the clearance between the strap and the brass be checked and if anything other than a snug fit is found the brass can be built up with a welding torch and dressed down to fit. The threads in the wedge and on the bolts should be checked for snugness. Operate with a minimum safe clearance between pin and brass surfaces. Do not allow bearing to pound.

Fresno, Calif. G I WOODS

Look for Wedge Wear

WE HAD TROUBLE SIMILAR to AAF's on a 400-kw unit; several bolts snapped off at the head in a single week. In making the bolts, the machinist had formed a square corner where the head connects to the body, leaving a definite ring or tool mark at that point. The break followed the tool mark as glass cracks along the mark made by the cutter. Making the bolts with a fillet cured the trouble.

In another plant, there had been no wedge-bolt breakage in years, then three broke in as many days. The first broke at the head and the other two in the threads at the top of the wedge. After the third break, examination of wedges



and brasses showed a slight shoulder worn in the brass by the wedge and a slight wearing action was noted on the rod side of the wedge, made by the wedge action against the rod surface. This was all so slight as to pass unnoticed by the first repair crew. The brasses, rod, and wedge were sent to the machine shop and all three parts were planed and fitted. No more trouble was experienced for six years. The slight shoulder caused the wedge to be pulled out of line when the bearing was taken up, putting a strain on the bolt where it entered the wedge.

Maywood, Ill. G W REDMAN

Use Single Bolt, Shims

I HAVE NOTICED that wedge-bolt breakage usually occurs when brasses need taking up and is caused by the hammering action

(*Continued on page 158*)

SHORT QUESTIONS — QUICK ANSWERS

General Plant Practice

Q—Where is the dividing line between high-speed and low-speed engines? Is the speed classification of engines based on piston speed or rpm?

A—The dividing line may be set at 200 rpm. Revolutions per minute are generally considered in classing engines as to speed.

Q—Explain the use of an exhaust head.

A—An exhaust head is a funnel-shaped fitting, with the upper edges turned inward. It is used at the top of a vertical atmospheric exhaust line from a steam engine, usually above the roof and outdoors. It serves to trap oil and condensate following upward along the internal surfaces of the exhaust line. Some claim that exhaust heads muffle objectionable noise.

Q—Which is the best way to compare engines as to economy?

A—Theoretically, engines should be compared on a basis of Btu per hphr or per kwhr. This allows for differences between steam conditions and between types and kinds of engines. On this basis, for example, diesel and steam plants can be compared. However, in common practice, steam engines are compared in terms of steam rate or "water" rate, that is, lb of steam per hphr or per kwhr. Diesel engines are usually rated in lb of oil per hphr, since diesel oils do not vary widely in heating value. Gas fuels vary widely in heating value, and gas engines are usually rated in Btu per hphr.

Q—Would there be any advantage in a heating system operating at 5 lb and 400 F, as compared with the usual system operating at 5 lb saturated?

A—Most of the heat liberated in a steam-heating system comes from condensing the steam. This *latent heat of vaporization* is so large in relation to heat liberated due to steam temperature that any increase in steam temperature would have little value. A definite disadvantage of such a system lies in the hazard of extremely hot radiators.

Q—Operating a boiler at high ratings means getting more steam per dollar of boiler investment and more steam per cu ft of boiler-house space—in other words, it is possible to do a given job with a cheaper, smaller boiler. What are the disadvantages?

A—Operation at high ratings tends to shorten life of equipment, and also tends to increase maintenance costs. High rating operation usually means higher furnace temperatures and may cause clinkering and slagging troubles.

Q—Considering the thickness of a boiler tube to be 0.1 in. and the diameter to be 4 in., what boiler pressure would it be expected to carry at a factor of safety of 5?

A—Assuming the tube is seamless and has a tensile strength of 60,000 lb per sq in, the working stress would be 60,000 divided by 5 or 12,000. Using the formula for "hoop" stress:

$$P = 2 \times t \times WS \div D$$

where P equals pressure in lb per sq in, t equals wall thickness, WS equals working stress, and D equals diameter in inches, we get

$P = 2 \times 0.1 \times 12{,}000 \div 4 = 600$ lb per sq in.

However, tests and experience show this formula not desirable for boiler tubes. The ASME Code for Power Boilers gives this formula:

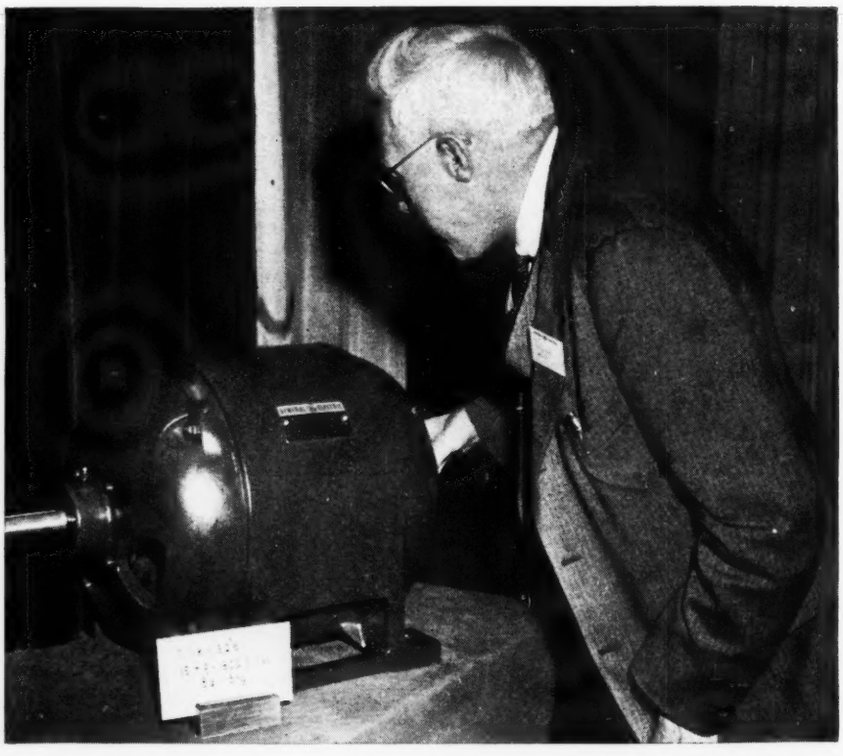
$$P = \frac{(t - 0.039)}{D}\ 18000 - 250$$

This formula yields a value of 24.5 lb per sq in. The next higher unit of 10 is allowed so 30 lb per sq in. is OK.

Q—In what three ways is heat transmitted from fuel to water in a boiler?

A—*Radiation* carries heat directly from the fuel bed to exposed tubes; *convection* carries heat from fuel to tubes by way of the hot furnace gases; *conduction* carries heat through tubes to water.

POWER EDITOR AT WORK



Associate Editor Fred Annett, POWER's authority on matters electrical, gives the new General Electric "Tri-Clad" polyphase induction motor the once over. The motor features a cast-iron frame and a new magnet wire

How to Figure Pressures

By PHIL SWAIN

EVERY POWER ENGINEER works constantly with the pressures of water, steam, oil, air, city gas and other fluids. In ABC fashion this article will show how pressures act on fluids at rest, neglecting weight. A future article will include the effect of weight.

To avoid any argument about fluid weight, for the moment, let's assume we are dealing with an imaginary weightless gas; call it "ghost gas." Fig. 1 shows an irregular container full of ghost gas under pressure. If pressure is 100 lb per sq in. at gage, as shown, it will be the same at every other point in the system, regardless of distance, level or direction. This is illustrated by the little pistons of 1 sq in. cross-section.

If the hydraulic press (Fig. 2) is filled with water or oil, a downward push of 1000 lb on the small plunger will produce an upward push of 100,000 lb on the large. Here the actual fluid pressure per sq in. is the same on both plungers, but this pressure acts on 100 times the projected area in the case of the ram (large plunger), hence multiplies the force 100 times. (Note: Areas of circles are proportional to the squares of their diameters. If diameter is multiplied by 10, area is multiplied by $10 \times 10 = 100$). In Fig. 2, bottoms of plunger and ram are at same level, so weight of liquid makes no difference.

Every now and then some inventor announces that he will increase the push on an engine piston by making the piston head conical so the pressure will act on more area. Such attempts are always licked by the fact that the push on each sq in. of a conical head acts at an angle with the piston rod. The components in the direction of the rod add to give exactly the same piston push as if the piston head were flat. With any piston or plunger the total push equals the pressure per sq in. times the sq in. of cross-sectional ("projected") area. In the case of a piston, this cross-section is that of either cylinder or piston (they are the same). In the case of a plunger be sure to figure area from plunger diameter, not inside diameter of cylinder.

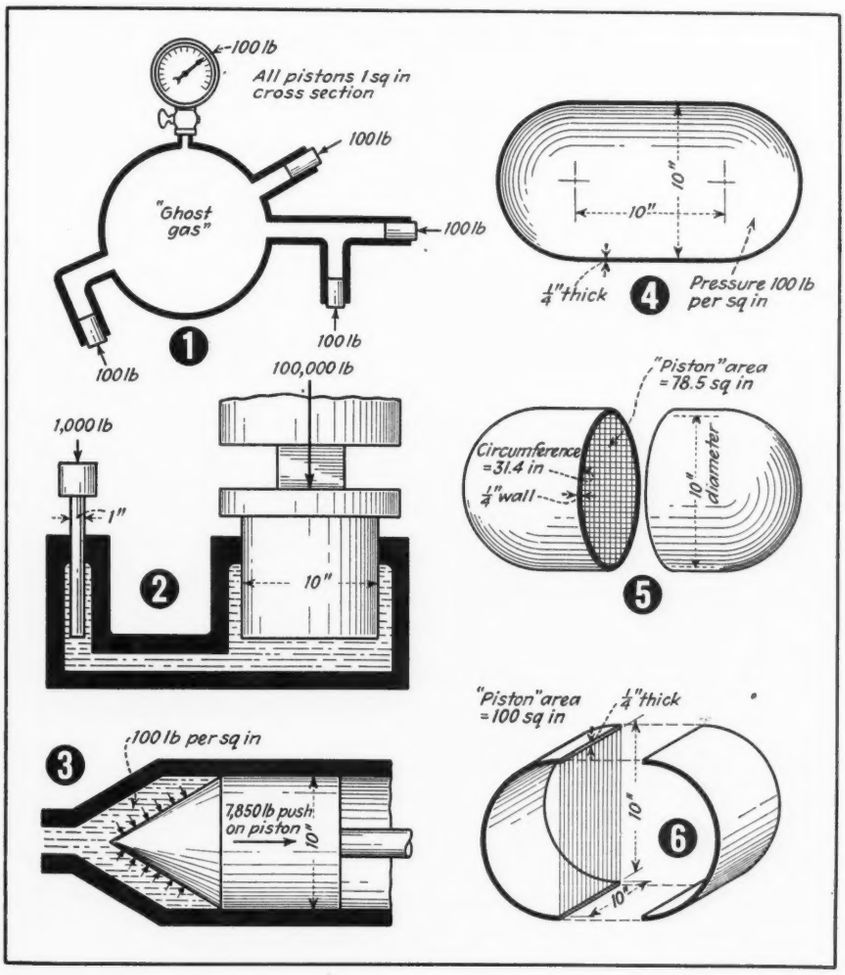


Fig. 1—If fluid is at rest, and of negligible weight, pressure is constant throughout system and in all directions. Fig. 2—Hydraulic press multiplies force by ratio of plunger cross-section areas. Fig. 3—Shape of piston head cannot change push on piston, which is always cross-sectional (projected) area times fluid pressure per sq in. Fig. 4—All-welded tank has hemispherical ends. Internal diameter and length of straight parts are both 10 in., shell thickness ¼ in. Fig. 5—Circumferential break. Fig. 6—Longitudinal break of straight section

Pressure in Tanks

To determine the strength of a tank or pressure vessel (such as the all-welded job of Fig. 4), we consider the various ways in which it might fail and figure each separately. Here the hemispherical heads are over-strength and give assurance that the tanks must fail in the straight part, if anywhere.

Consider first a circular failure (Fig. 5) and then a longitudinal (Fig. 6). In Fig. 5 the "piston" area is that of a 10-in. circle (78.5 sq in.), so the separating force is $100 \times 78.5 = 7850$ lb. This is resisted by a steel ring of 10 in. internal diameter and ¼ in. thick. Inside circumference is $3.14 \times 10 = 31.4$ in., so metal section area (approximately) is $31.4 \times ¼ = 7.85$ sq in. Then the unit stress in the steel is $7850 \div 7.85 = 1000$ lb per sq in., which is safe by an extravagant margin.

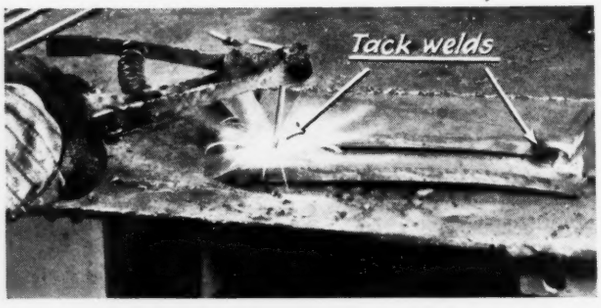
For the break shown in Fig. 6 (neglecting any reinforcement by the heads), the force on the "piston" is $10 \times 10 \times 100 = 10{,}000$ lb. The resisting metal has an area of 5 sq in. (two strips 10 in. $\times$ ¼). Hence the unit stress in the metal is $10{,}000 \div 5 = 2000$ lb per sq in., still extra safe, but double the unit stress for a ring break.

HOW TO LAP WELD

(Prepared with the cooperation of the Lincoln Electric Co, with photos posed by POWER *in Lincoln's New York demonstration rooms)*

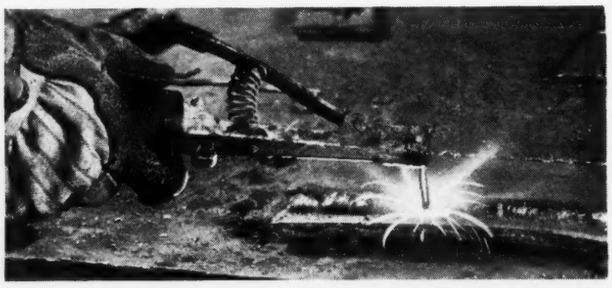
► THE three preceding articles showed "How to Strike an Arc and Run a Bead," "How to Make a Butt Weld," and "How to Make a Vee-Butt Weld." This article completes the series by showing the application of fillet welds to make a lap joint and to connect two plates at right angles.

For both exercises the plate may be of any thickness, but 3/8-in. would be convenient for this lesson.

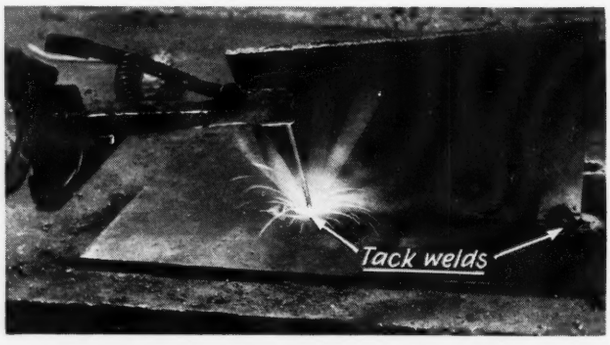


1 **To start a lap weld, overlap plates and tack-weld two ends as shown. No beveling of plates is necessary**

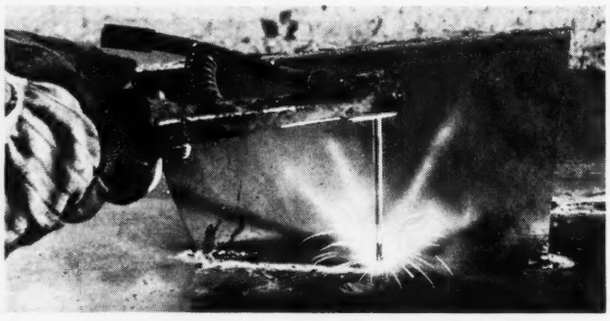
2 **Lay the first bead (fillet) in the corner formed by the overlap of the two plates. Penetration down in the corner is important. Use the back-and-forth weaving motion shown in F or G of Fig. 1, December POWER, page 112. Modify weave as necessary to avoid undercut on top plate or overlap on bottom plate**



3 **If the plate is thicker than ¼ in., it will often be necessary to run more than one bead to fill up the angle between the plates. Before running each bead, clean all the scale from the preceding bead with chisel and wire brush. Then run bead with weaving motion as described in step 2**

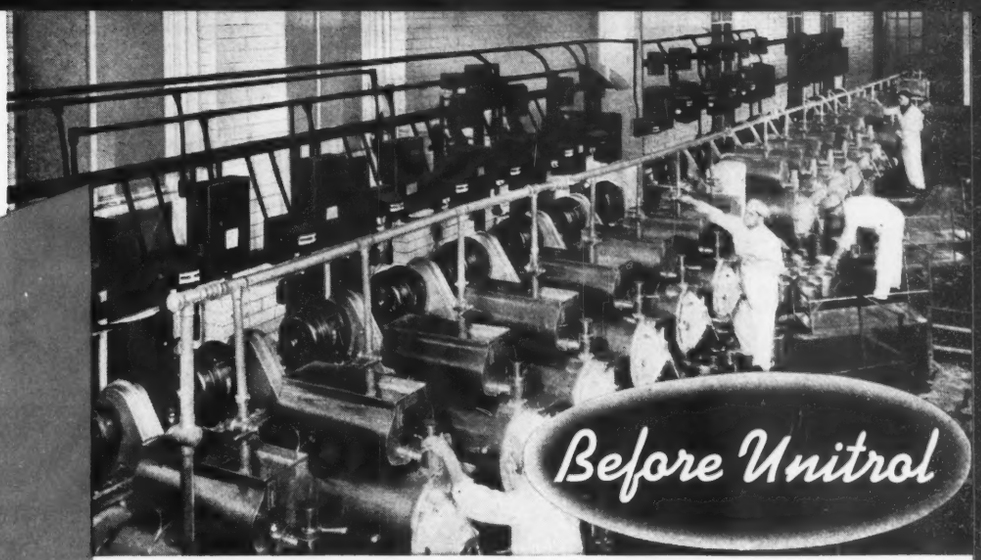


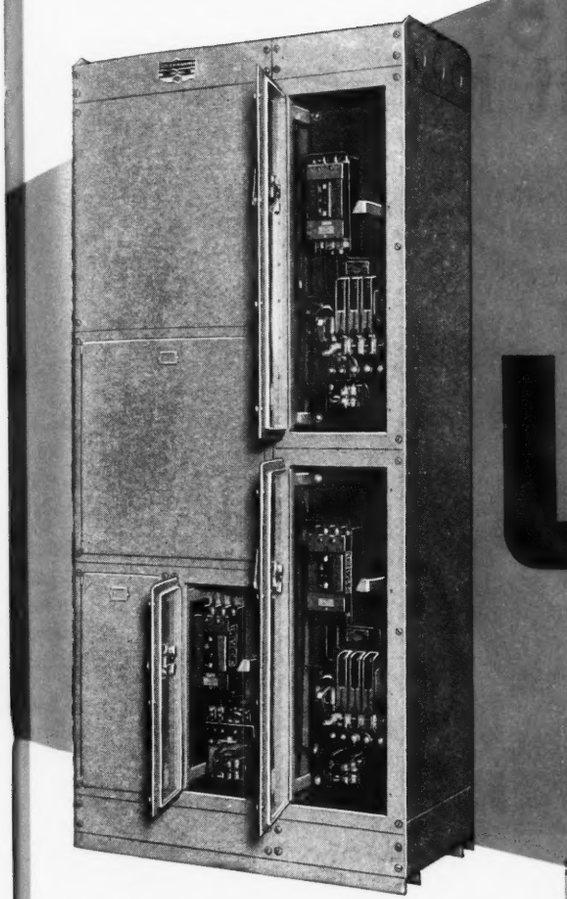
4 **To make a tee weld, first set up the two plates at right angles in the desired position and tack-weld as shown**



5 **Keeping the electrode tilted at about 30 deg from vertical plate, move rod slowly along the joint in a straight line to build up small fillet like that shown. Note that the horizontal plate (because it extends in both directions) will absorb more heat than the vertical plate. The position and movement of the electrode should therefore "favor" the horizontal plate. It is important that the first bead penetrate to the corner. Use a short arc and don't advance it too rapidly.**

In the case of the tee weld, thickness of the plate does not give correct indication of the size of the fillet. Therefore, weld metal may be put in layer after layer to give the size desired for the kind of service. If additional layers are desired on the first fillet weld, clean each bead with wire brush and chisel before applying next layer. Deposit layers with weaving motion





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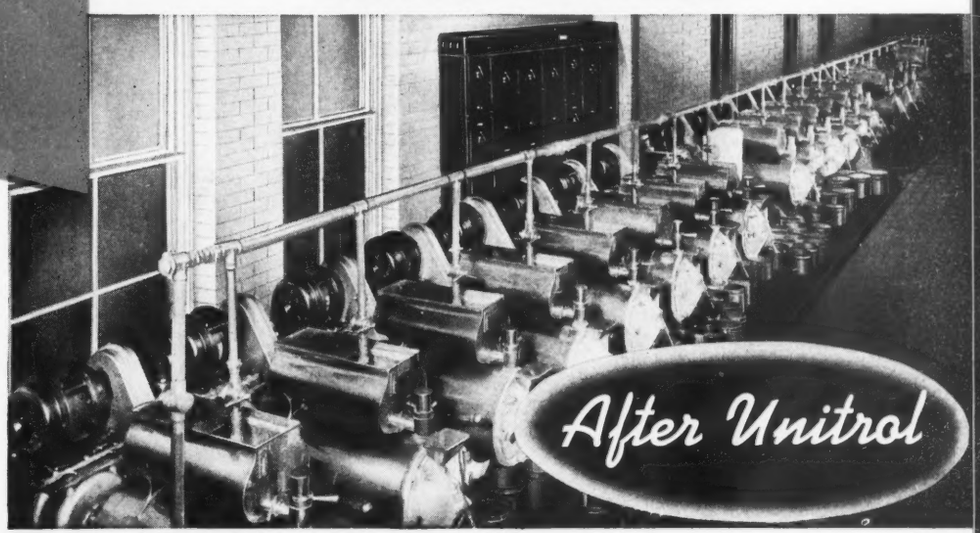

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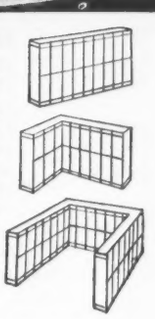

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Miniature Sulphur Burner Treats Feedwater at Necco

Electrically heated burner converts two to three ounces of sulphur per hour into SO_2 for neutralization of dissolved oxygen in boiler feed water at Cambridge (Mass.) plant of New England Confectionery Co

By GEORGE A JOHNS
Chemist, Boston, Mass.

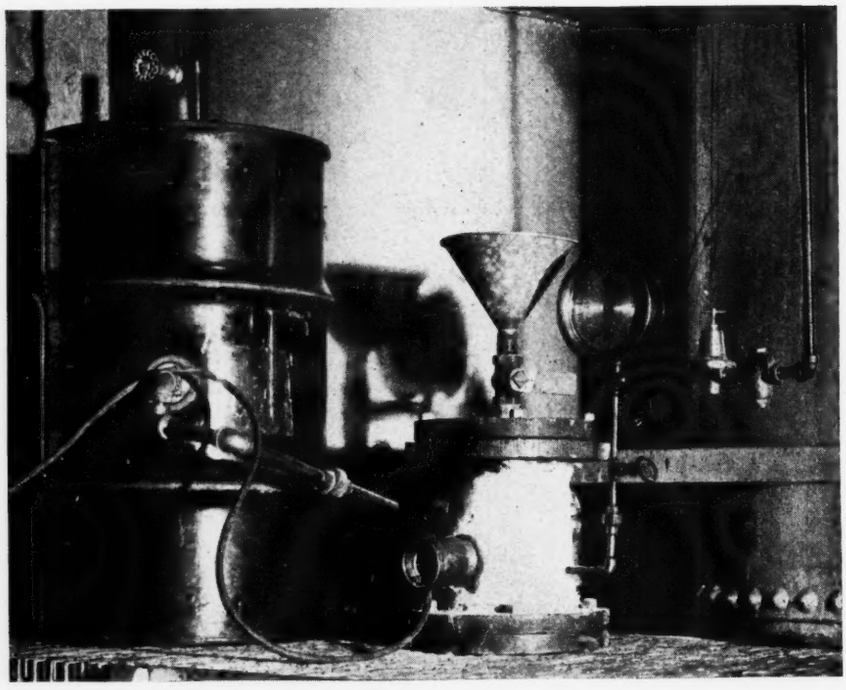

Fig. 1—Scrubber (left) was made from a 30-gal drum; sulphur burner (right) largely from pipe fittings

► OF THE MANY FACTORS that contribute to corrosion of metals in water and steam systems, the presence of oxygen is most important. The usual technique of deoxygenation is, first, to deaerate the water mechanically, then add oxygen-consuming chemicals (ordinarily sodium sulphite) to control any residual oxygen.

Sodium sulphite was first practically demonstrated in 1920, but, on water that had not been mechanically deaerated, proved too expensive and was therefore discontinued. Attention was again called to sodium sulphite in 1931.[1] Since that time, the availability of this chemical at reasonable cost has greatly increased its use, but economy still demands the removal of the bulk of the oxygen mechanically. The sodium sulphite in low concentrations is then used as an oxygen scavenger.[2]

It is feasible to replace sodium sulphite with sulphur dioxide at a much lower unit cost, and at the same time correct any deficiency of sulphates to maintain the ASME ratios. This method was first reported in 1939,[3, 4] the original research being conducted by the Freeport Sulphur Co. Since that time, the writer has experimented with a small sulphur burner having a capacity of between 2 to 3 ounces per hour.

The first of these miniature burners is now operating in the boiler plant of the New England Confectionery Co, Cambridge, Mass. This plant has a maximum evaporation of about 360,000 pounds daily at a pressure of 250 lb. Makeup is 65%, and the residual oxygen content 0.8 ppm. The boilers are treated internally with phosphate and soda ash, the blowdown being determined by sulphate concentration.

Up to a year ago, these boilers had been treated with boiler compound, but were troubled with scale. Analysis showed this scale to be largely sulphate. As it dissolved, an increasingly large blowdown was needed to maintain a sulphate-alkalinity ratio of 2. This sulphate curve reached its peak in about seven months operation, after which it was necessary to add sodium sulphate to maintain the desired ratios, along with sodium sulphite to control the oxygen.

At this time, we decided to adapt the small burner to the conditioning of the boiler feedwater. After considerable difficulty, because of the very low desired rates of sulphur burning, we developed the burner shown in the photographs and sketches.

Adding SO_2

A solution of sulphur dioxide in an alkaline medium is added to the feed tank, at the rate of about 2 gal. per minute. Part of this is bypassed into the headers and open heater where considerable corrosion has been encountered in the past. The main portion of the alkaline mixture, together with the phosphate, is then pumped into the suction side of the main feed line, thus offering protection to the greater part of the feedwater circuit.

Sulphur dioxide requires considerable contact period for oxidation. At ordinary temperatures this reaction is far too slow, so manganous sulphate is used as a catalytic agent to increase the velocity of oxidation. 1 ppm added to the feed tank causes an oxidization of

[1] Moberg, *Combustion*, 1931, page 36.

[2] "Oxygen Removal in Boiler Feedwater by Sodium Sulfite", Kobe and Gooding, *Industrial and Engineering Chemistry*, 1938, pages 331-3.

[3] "Use of Sulphur Compounds for Treatment of Water and Industrial Wastes", Carpenter, Setter and Coates, *Journal Am. Water Works Assn*, August 1939, pages 1440-6.

[4] "New Low-Capacity Sulphur Burner", G H Cain, J B Chataline, *Chemical & Metallurgical Engineering*, October 1939, pages 637-9.

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ALL PRESSURES
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Low cost . . . It is frequently cheaper to install a new Yarway trap than to try to repair an old, worn, ordinary trap.

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Miniature Sulphur Burner Treats Feedwater (Continued from page 118)

75% before the water is pumped into the boiler. Enough sulphite remains to control the residual oxygen in the boiler, concentration at blowdown being about 20 ppm as Na_2SO_3.

The technicalities of the process lay in both the burner design and the adaptation of the procedure to the particular plant. It appears impossible to standardize the burner, because shape, size, and weight of materials used govern its effectiveness. The burner must have a fairly constant rate of burning.

This small burner has a mean variation of about ± 15% over the 16-hour run. It is simple to build, economical to operate, and requires very little attention other than igniting, reading temperature each hour and analyzing the gas periodically if necessary.

The sulphur dioxide from the burner is absorbed in the charcoal-filled gas scrubber. Since the water is alkaline, the scrubber need not be lead-lined. The

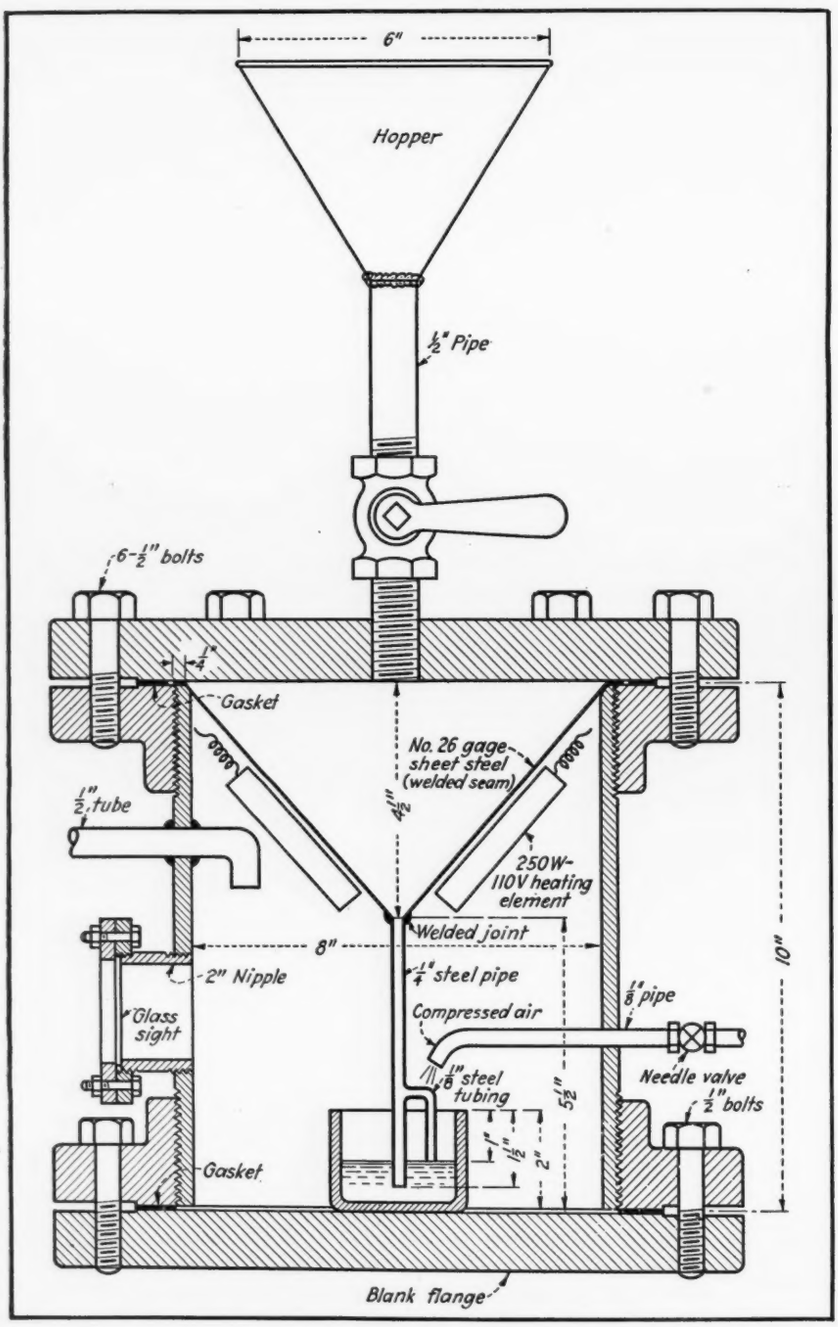


Fig. 2—This burner works satisfactorily when burning as little as 2 oz sulphur per hr

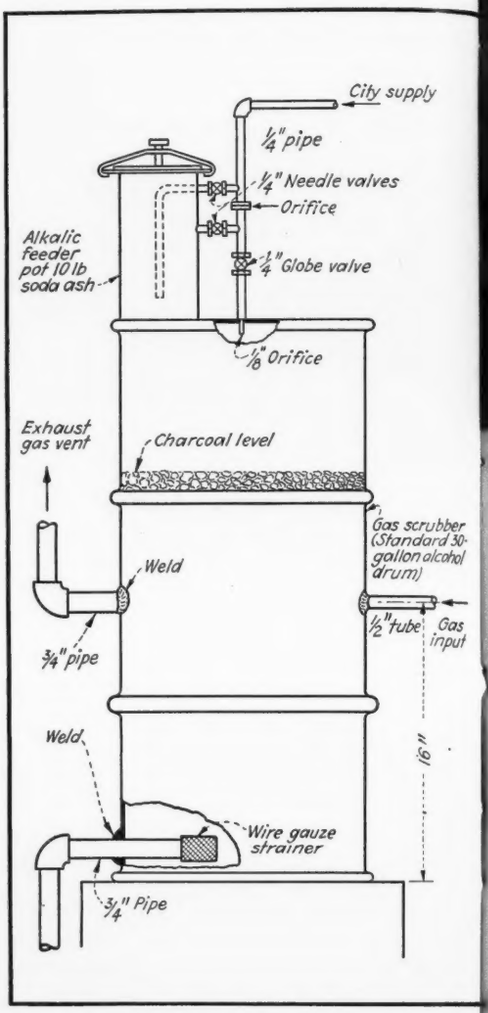
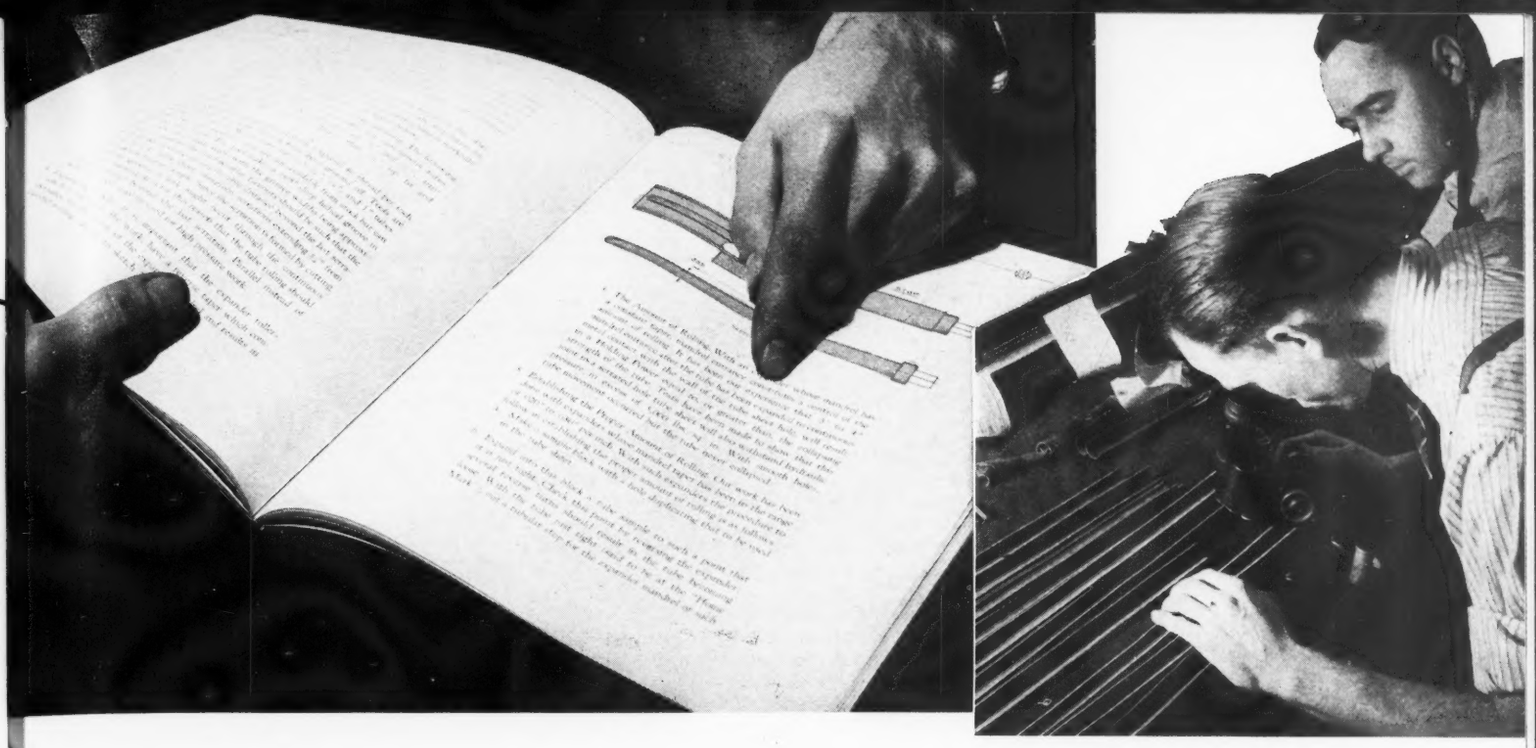


Fig. 3—Scrubber, made from steel drum, absorbs SO_2 in alkaline solution

process is technically and chemically feasible[3, 4] and offers a number of advantages even in a plant of this size. These include the saving on sulphate and sulphite ($12.55 per million gallons of water in this plant), handling and storage of only one chemical and a decrease in total solids in the boiler.

In the writer's opinion, *total* deaeration is possible at a very low cost per unit without the necessary investment for mechanical deaerators. The process should be applicable where either acid or alkaline sulphur compound is required.

The writer is grateful to the New England Confectionery Co, and to S B Starratt, chief engineer, for their interest, which has made possible this small step in the adaptation of the sulphur-burning process to boiler-water treatment.



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ENGINEERS' BOOKSHELF

Drafting

TECHNICAL DRAFTING (1940). *By Charles H Schumann, Associate Professor of Drafting, Columbia University, New York. Published by Harper & Brothers, 49 East 33rd St, New York, N. Y. 793 pages, about 1000 illustrations. Price $3.50.*

This very complete volume presents engineering drafting as used in industry. Many industrial corporations and architects contributed to its preparation. Elementary principles of drafting are discussed, but practicing engineers will be more interested in sections on professional drafting. Detailed drawings of welded constructions, engineering and scientific graphs, shading, topographic draftings, architectural drafting and design, power plants, generating and distributing stations and many others are included. Some 200 of the 1000-odd drawings represent working and shop drawings actually used in industry.

Electric Utilities

DICTORY OF ELECTRIC UTILITIES (1940). *Published by Federal Power Commission, Washington, D. C. 800 pages, 6x9 in. Price $2.00.*

A directory of names, addresses and principal officers of electric utility companies operating in the United States, giving controlling and controlled companies, assets and revenues, number of customers and generating capacity, kwhr generated, communities and other utilities served. Not only are privately owned utilities listed but also included are industrial establishments rendering incidental electric service, publicly owned utilities (municipals), mutually owned and cooperative utilities.

Welding

WELDING METALLURGY. *By O H Henry and G E Claussen, Polytechnic Institute of Brooklyn. Published by the American Welding Society, 33 West 39th St, New York, N. Y. 359 pages, 5 x 8 in., illustrated. Price $1.50.*

A brief and simple text that covers the metallurgical problems involved in welding in a manner understandable to members of the welding industry. Originally presented as a series of 18 lectures, reproduction in book form, fully illustrated, brings understanding of the welding process as it affects structure of the material in more simple words than heretofore available.

Subjects covered include: temperature changes during welding, types of steels and their manufacture, crystals, how crystals grow from other crystals, why crystals are strong, the weld melt (pure iron), the weld melt (steel), iron-ironcarbide equilibrium diagram, difficulties, the solid weld, rate of cooling, alloy steels, metallurgical constants, heat and time in welding, the weld during cooling, brittleness and cracking, shrinkage, fluxes and slags, stainless steels, preheating and stress relief.

ARC-WELDING HANDBOOK. *By Karl Meller, translated from the German by J E Webb Ginger. Published by the Chemical Publishing Co, 148 Lafayette St, New York, N. Y. 210 pages, 5 x 7 in., 83 illustrations. Price $3.50.*

A handbook in simple language intended as a practical aid to the small welding shop. Covers arc welding in a practical manner with a detailed analysis of electrode material, size, and optimum current. Contains a chapter on calculation of costs and another on welding non-ferrous alloys. Practices and technique described are basically of German development and afford an interesting comparison with those of this country.

Materials

MATERIALS HANDBOOK (1940, Fourth Edition). *By George S Brady. Published by McGraw-Hill Publishing Co, 330 West 42nd St, New York, N. Y. 591 pages, 6 x 9 in. Price $5.00.*

Revised and enlarged edition of this standard encyclopedia of complex materials of modern industry, from "abrasives" to "zirconium-ferrosilicon", gives a brief summary of important chemical and physical properties of each subject. Such items as the composition of non-magnetic steel, how glass fiber is spun, the uses of chromite refractory, illustrate the wide range of information given in brief dictionary form. Of immediate value to anyone requiring a quick reference.

Calculus

TREATISE ON ADVANCED CALCULUS (1940). *By Philip Franklin, Professor of Mathematics, Massachusetts Institute of Technology. 595 pages, 6 x 9 in. Price $6.00.*

Designed primarily as a text for graduate students, it can be read by those already reasonably proficient in calculus. All necessary prerequisite differentiation and integration operations are covered so that the work is independent of any particular previous texts.

Temperature Control

TEMPERATURE — ITS MEASUREMENT AND CONTROL IN SCIENCE AND INDUSTRY (1940). *Composed of papers presented by authorities at Symposium sponsored by American Institute of Physics. Published by Reinhold Publishing Co, 330 West 42nd St, New York, N. Y. 1300 pages, 550 illustrations. Pre-publication price (before Feb 1, 1941) $9.00, list price after that date, $11.00.*

Fundamental knowledge in the field of temperature and its measurement is covered in this volume. Collection of 125 papers by eminent engineers, metallurgists, physicists, physicians and biologists, it presents descriptions of all phases of temperature technique, and theoretical treatment of the thermodynamics and physics which underlie the various temperature scales.

Scope of this volume is remarkably inclusive. It ranges from closest possible approach to absolute zero to temperature of the stars; from the production and loss of heat in the body to measuring the temperature of volcanoes. Many methods of precision pyrometry are described in detail. Also covered are the cooling of massive concrete structures, low-temperature cancer therapy, temperature conditions in oil-well drilling, high-temperature arcs, molten-steel pyrometry, and many others.

BRIEF REVIEWS

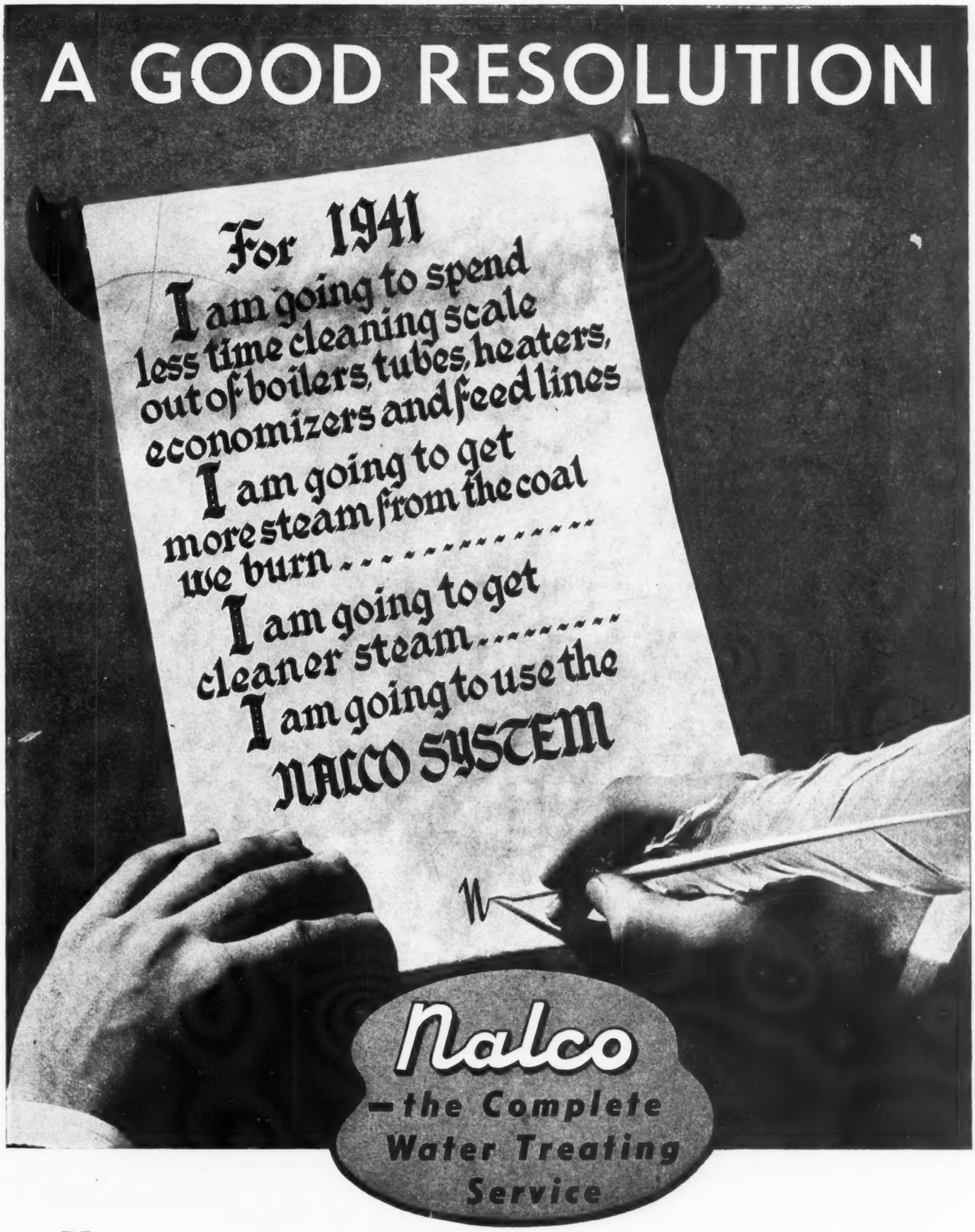
SUGGESTIONS FOR PROTECTION OF INDUSTRIAL FACILITIES. *Issued confidentially by the Federal Bureau of Investigation, U. S. Dept of Justice, Washington, D. C. Available only on application by a responsible officer of an industrial corporation concerned with national defense.*—Contains general suggestions for improving protection against sabotage and espionage primarily in industrial establishments but adaptable to public utilities, transportation and other facilities. Copies are numbered serially and must be returned on request.

HOW TO CHOOSE A SLIDE RULE. *By Don Herold. Published by Keuffel & Esser Co, New York, N. Y. 2 colors, paper bound. Available on request.*—A description for the layman of the different types of slide rules available. The author, using non-technical language, brings out uses of different rules and tells prospective buyer the qualities he should look for in a slide rule to fit his requirements. Humorous cartoons accompany text. Covers Mannheim, polyphase, polyphase duplex trig, log log duplex, log log duplex vector, and decitrig rules.

MODERN PLASTICS CATALOG (1940). *Published by Modern Plastics Magazine, 122 East 42nd St, New York, N. Y. 476 pages, price $3.50.*—Covers completely the plastics industry in the United States. Consists of nine divisions, all relating to plastics: Materials, Machinery and Equipment, Plastic Coatings, Plastics Properties, Plasticizers, Solvents, Molding and Fabricating, Laminates, and a Directory.

STANDARDS OF HYDRAULIC INSTITUTE—(7th Edition—1940). *Published by Hydraulic Institute, 90 West St, New York, N. Y. Price $1.25.* Enlarged publication has been rewritten and rearranged, with much new material added. This includes new pump test code, charts

(Continued on page 156)


A GOOD RESOLUTION
For 1941
I am going to spend
less time cleaning scale
out of boilers, tubes, heaters,
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more steam from the coal
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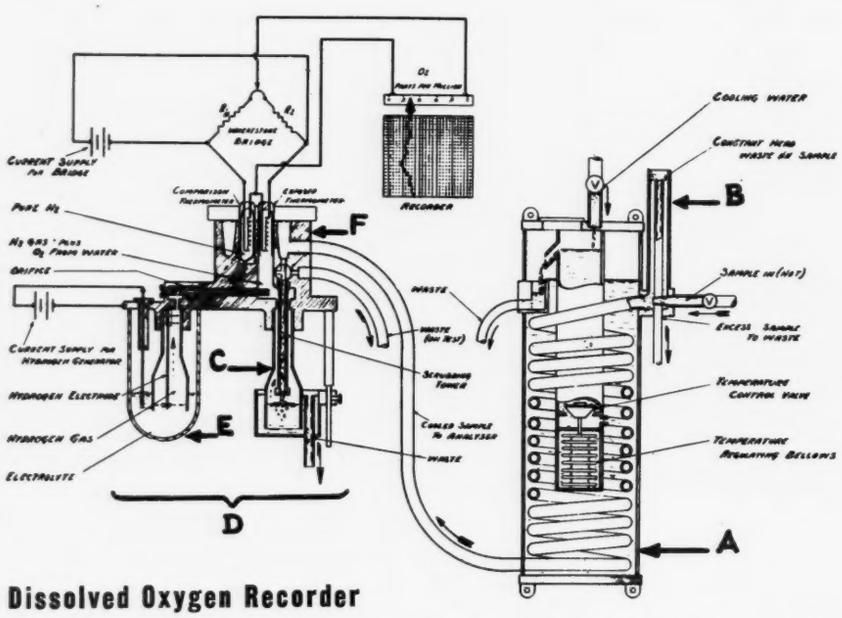
WHAT'S NEW IN PLANT EQUIPMENT

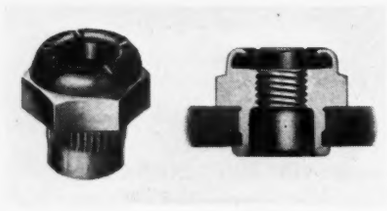


Dissolved Oxygen Recorder

AUTOMATIC recorder provides continuous indication and record of dissolved oxygen entering boiler. Sensitivity of instrument said to be such that dissolved oxygen in feedwater can be measured to one part in 400,000,000. As shown in diagram, water to be analyzed enters cooler-regulator *A*, where it is reduced in temperature and maintained at approximately 85 F. Constant head device, *B*, maintains correct flow of water through scrubbing tower, *C*, of analyzer unit, *D*. Hydrogen is generated in electrolytic cell, *E*, and flows to scrubbing tower where it comes into intimate contact with sample water. Water dissolves some hydrogen and gives up part of its oxygen. Resultant mixture of gases diffuses to meter block, *F*, which contains the sensitive elements. Latter consists of four platinum spirals connected in form of a Wheatstone bridge which are heated to definite value by current flowing through them. Two of the spirals are exposed to sample gas and two are permanently sealed with saturated hydrogen. When pure saturated hydrogen surrounds exposed spirals the bridge is in balance, and no deflection of recorder occurs, thereby indicating zero oxygen. When exposed spirals are surrounded with a mixture of hydrogen and oxygen their temperature will increase due to lower thermal conductivity of mixture. This causes a change in resistance of spirals with consequent unbalance of bridge circuit. Deflection of recorder is, therefore, proportional to concentration of dissolved oxygen in sample water passing through scrubbing tower. *Cambridge Instrument Co, 3732 Grand Central Terminal, New York, N. Y.*

Lock Nut

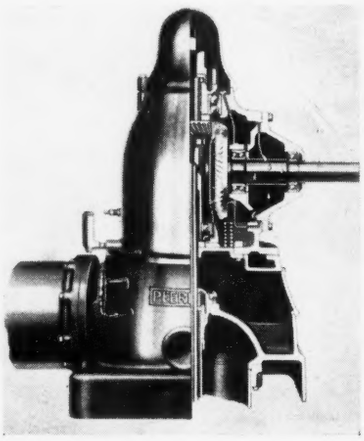
FOR FASTENING sheet-metal assemblies in which parts must be readily removed, clinch-type lock nut with knurled shank has been developed. To install nut, holes are drilled in structure and shank is



pressed into hole. Mouth of shank is then spread against the back of the structure to effect a clinching hold. Knurling engages drilled surface and thus assists in eliminating any nut turning. Head of nut is fitted with vulcanized fiber collar characteristic of Elastic nuts. This collar, being unthreaded, resists entrance of screw, thus automatically taking up all thread play and bringing load-carrying thread faces of nut and screw into a tight-pressure contact. *Elastic Stop Nut Corp, 2332 Vauxhall Rd, Union, N. J.*

DC Recorders

CF LINE of inkless recorders has been extended to include direct-current instruments, available as voltmeters, ammeters, millivoltmeters, milliammeters, and microammeters in ratings down to 125 microamperes full scale. CF2 recorder is portable, may be wall or pole mounted, and is suitable for indoor or outdoor application. May be operated at temperatures ranging from —10 to 120 F. Electric element is concentric magnet dc element, shielded from stray magnetic fields, and housed in weatherproof case of aluminum-alloy. *General Electric Co., Schenectady, N. Y.*



Pump Head

GEARTURBO PUMP HEAD has several improvements in 1941 models, including change in bearing application. Double-row ball bearings support horizontal and vertical shafts and are placed adjacent to spiral bevel gears. Extra-heavy-duty thrust bearing supports lower end of geared shaft sleeve, while an additional thrust bearing supports outer end of horizontal shaft drive. All four bearings are lubricated by oil-pressure system, which circulates cooled oil to both bearings and gears, and to prevent leakage of oil from outer bearing, on take-off shaft, an oil seal is placed on end of bearing housing. Head assembly is streamlined and gearing is completely housed for weather protection. Head provides for connection with universal shaft to gas engines, steam engines, and any other power unit. *Peerless Pump Co, 301 West Ave 26, Los Angeles, Calif.*

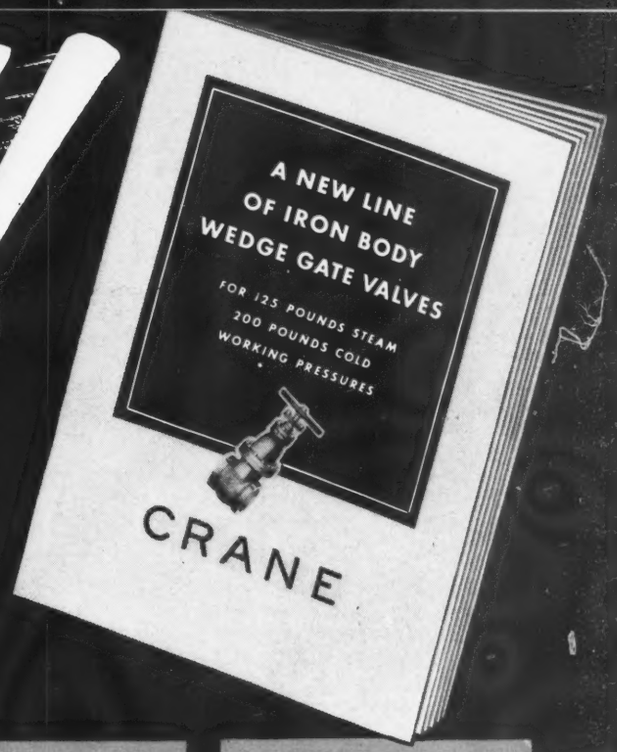
Isochronous Governor

GOVERNOR has automatic reversing valve in pump oil lines and may be operated in either direction of rotation. Connection between throttle and governor may be made in same manner as when using plain centrifugal governor. In this case, governor moves throttle to wide open when engine is stopped, and a flexible member, positive in closing direction, should be used in linkage to permit hand control without necessity of opposing full force of governor. Power piston of governor is provided with limit stops in both directions. Complete technical description can be found in bulletin 3200. *Pickering Governor Co, Portland, Conn.*

Rust Preventives

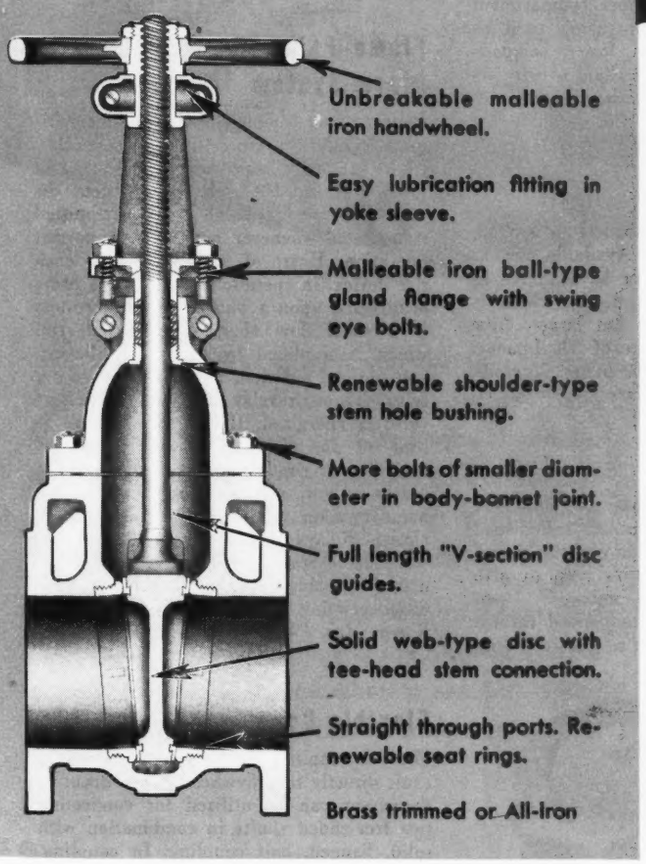
RUST preventive line includes grease-type (non-drying) products; drying, hard-film products, semi-drying (waxy film) and soluble rust preventives. Basic material provides homogeneous non-crystalline film, with high degree of cohesion as well as adhesion to metals. It wets out surface

FLASH!

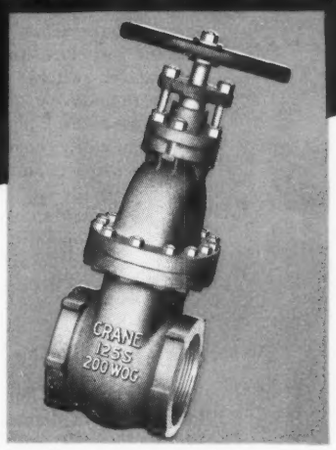


A new and complete line of Crane Iron Body Wedge Gate Valves for 125 pounds steam, 200 pounds cold working pressures. No increase in price. Improved design features extend adaptability for service and assure long trouble-free life under severest conditions. Complete specifications in catalog available from your Crane Representative or by mail request.

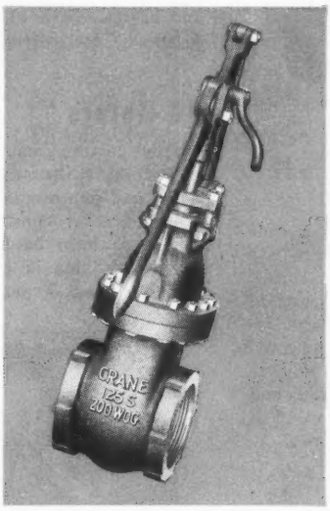
NEW FEATURES LIKE THESE IN ALL PATTERNS


Unbreakable malleable iron handwheel.
Easy lubrication fitting in yoke sleeve.
Malleable iron ball-type gland flange with swing eye bolts.
Renewable shoulder-type stem hole bushing.
More bolts of smaller diameter in body-bonnet joint.
Full length "V-section" disc guides.
Solid web-type disc with tee-head stem connection.
Straight through ports. Renewable seat rings.
Brass trimmed or All-Iron

OUTSIDE SCREW AND YOKE
Screwed and flanged ends. Also in alloy cast iron, flanged ends

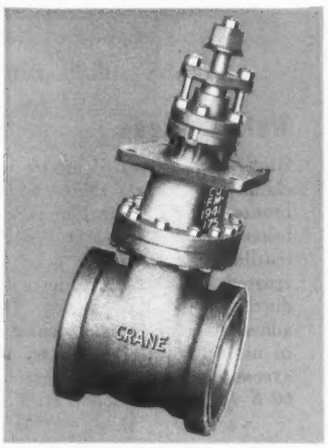


INSIDE SCREW, NON-RISING STEM
Screwed, flanged, hub ends



QUICK-OPENING TYPE
Screwed and flanged ends

MARINE CARGO SYSTEM VALVES
Flanged ends



UNDERWRITERS' PATTERNS
Screwed, flanged, hub ends

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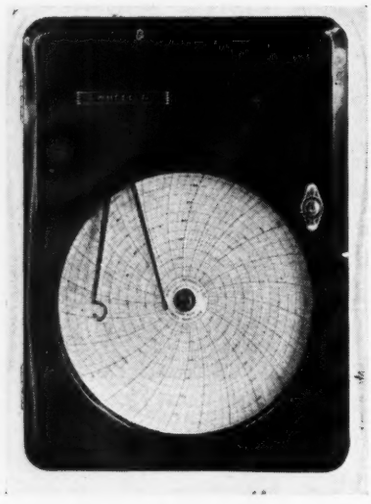
rapidly, making a non-tacky unbroken film impervious to atmospheric conditions. *E F Houghton & Co, Third & Somerset Sts, Philadelphia, Pa.*

Indicating-Recording Control Thermometer

WHEELCO THERM-OTROLS employ famous "Radio Principle" control. Frequency of oscillating current flowing between pick-up coils, which are mounted on temperature-control setting index, is changed when control flag, mounted on pen arm, is moved between coils by temperature rise. This change in frequency in control circuit operates to de-energize a solenoid coil and open relay contacts. Recording and temperature-measuring mechanism have no work to perform to effect control action and they receive no retarding or accelerating forces from control section. Two- and 3-pen recorders, or indicator-recorder combinations, can be supplied to read and control at one point and measure temperature at one or two additional points. *Wheelco Instruments Co, 1929 S Halsted St, Chicago, Ill.*

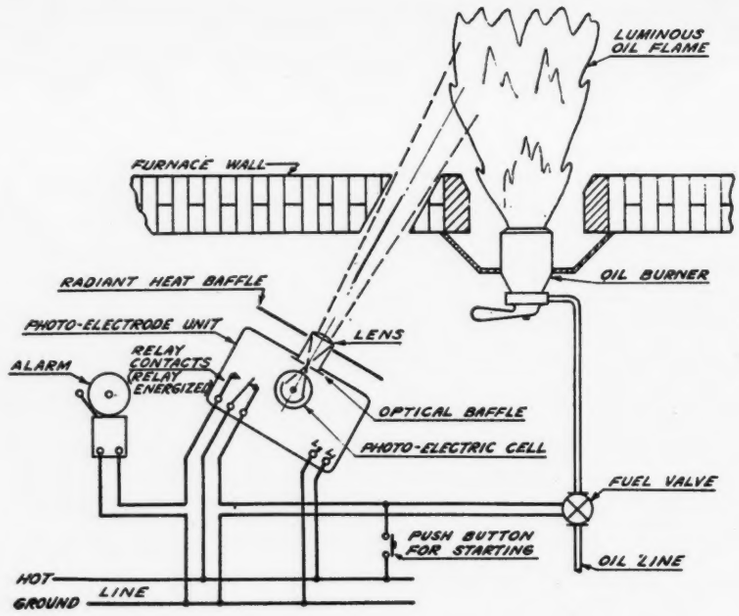


Welding Rods

HIGH-TEST flux-coated bronze welding rods claimed to have these advantages for bronze-welding operations: low fuming, faster application, denser deposit, increased tensile strength, greater bond strength, increased hardness of deposit, improved ductility, and time saving. Flux said to adhere to rod even in shipment of rods and in use, and will not fall off when rod is excessively bent. *Air Reduction Sales Co, 60 E 42d St, New York, N. Y.*

Step-Voltage Regulators

AIR-INSULATED step-voltage regulators supplement recent improvements in air-insulated electrical equipment for utilities. Construction of transformer element of regulator is conventional air-blast, air-insulated type. In order to reduce costs and space requirements, special transfer and selector switches were designed whereby six transfer switches and a selector switch could replace 18 transfer switches normally used on 2-phase, oil-insulated, 32-step regulator. Load-tap-changer consists of two compartments, upper compartment housing six de-ion air breakers used as transfer switches, while lower compartment houses operating mechanism with its motor control. *Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

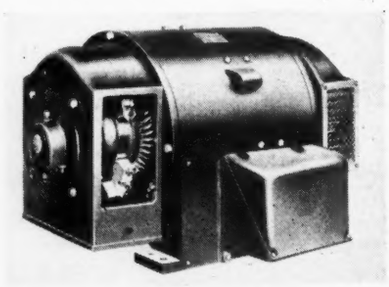


Fluorescent Lamp

HYGRADE 100-watt fluorescent lamp is 60-in. long, $2\frac{3}{8}$-in. in diameter. Available now in white (3500 F), will later be available in daylight. Base is Mogul Bi-pin, which is similar to present bases but larger. New lamp produces an average of 880 lumens, and has rated life of 2000 hours. *Hygrade Sylvania Corp, Salem, Mass.*

DC Motors

MOTORS feature compactness and improved protection. New design of rolled-steel frame and improvements in end-shield and bearing-bracket construction help to give protection from external damage. Open motors available in constant-speed ratings from $\frac{1}{2}$ hp at 850 rpm, up to and including



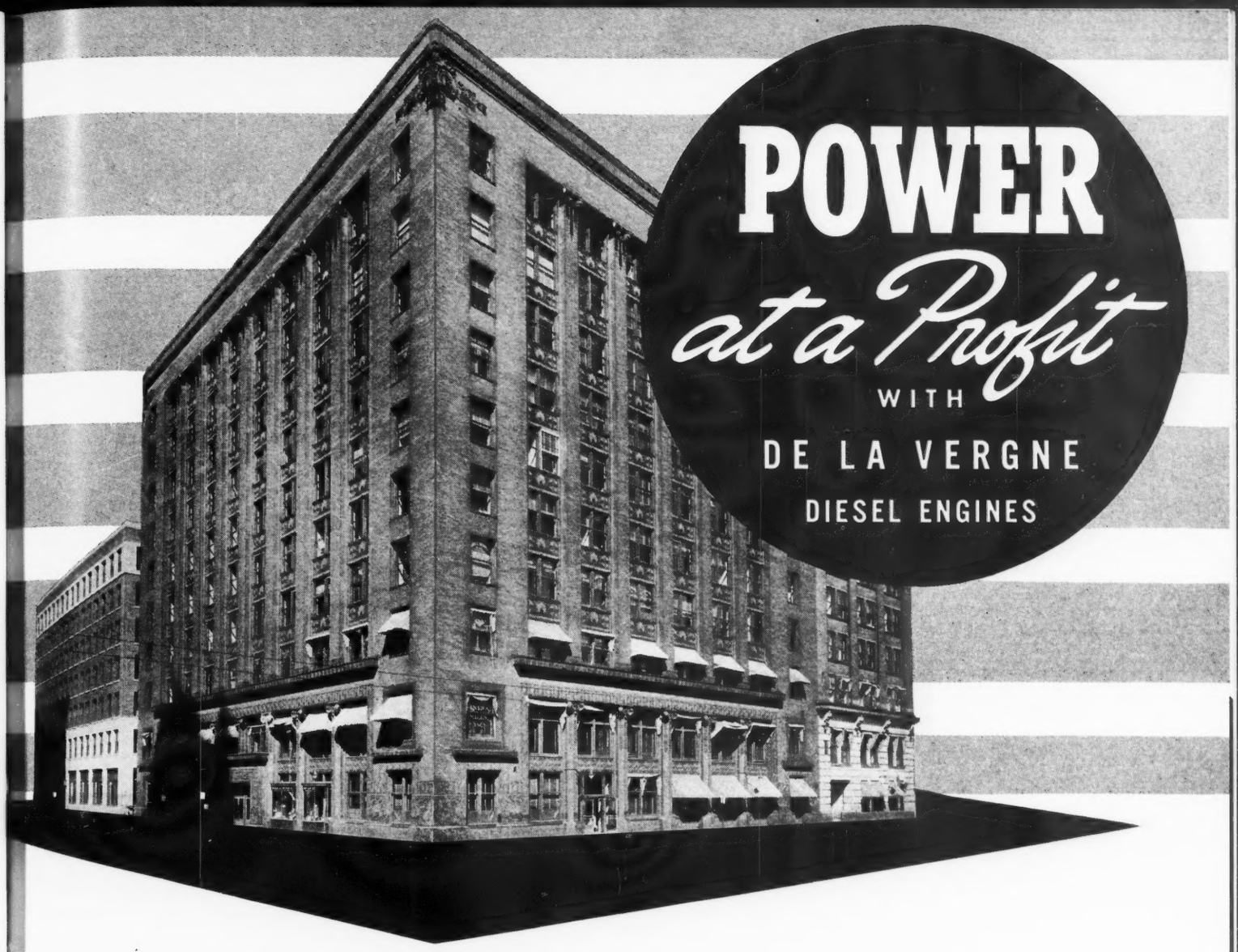
60 hp at 1750 rpm; and in adjustable-speed ratings from $\frac{1}{2}$ hp at 850/3400 rpm up to and including 15 hp at 500/1800 rpm. Motors in larger ratings (beginning at 50 hp, 850 rpm), have such features as new system of self-ventilation, extra protection of all current-carrying and rotating parts, and large conduit boxes. *General Electric Co, Schenectady, N. Y.*

Flame-Failure Alarm System (above)

PROTECTOGLO photo-electrode system is quite similar to other system using electrodes made by same company. Instead of using metallic electrode, this system detects presence of flame by light emitted from flame whenever burner is in normal operation. Heart of system is light-sensitive device. In operation, light from a flame is directed upon a photo cell. This results in a small flow of current through cell which is amplified by a vacuum-tube circuit until of sufficient magnitude to close a relay. Through relay contacts, main fuel valve is energized. If light from flame is shut off due to flame failure, photo cell is no longer conductive. Current in circuit ceases to flow, and relay drops out. In this manner main fuel valve is immediately closed. Relays are also provided so that when flame is shut off and fuel feed stops, alarm will ring, warning operator of condition existing. *Brown Instrument Co, 4490 Wayne Ave, Philadelphia, Pa.*

Flexible Coupling

MANGER coupling can be used to connect a shaft directly to a flywheel, brake drum or flange, or can be utilized for connecting two free-ended shafts in combination with solid, flanged, half coupling. In coupling, compensation for misalignment is made by internal sleeve which floats between an externally geared hub and internally geared covering sleeve. Internal sleeve, which engages hub and outer sleeve, is free to slide and rock, adjusting for difference in alignment. Driving member of coupling can be either geared hub or covering sleeve. Coupling is suitable for con-



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This economy record, plus the quietness and dependability of the engine, made a De La Vergne diesel the logical choice when a second engine was recently installed to furnish additional power.

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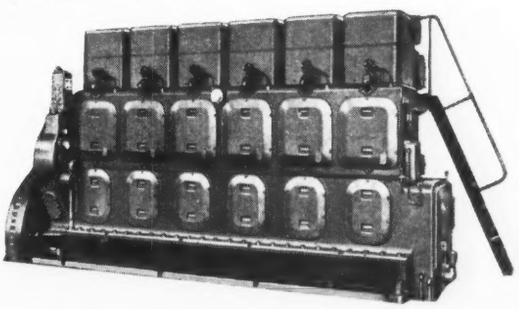

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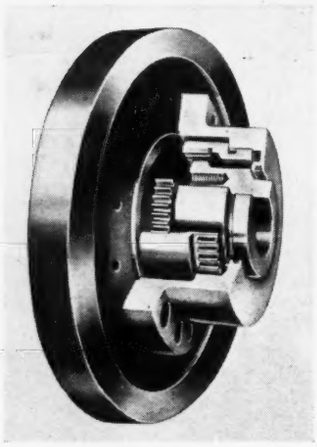


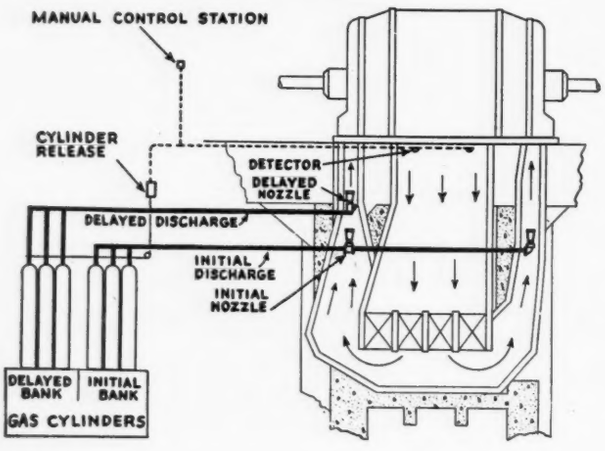
necting a shaft to an engine flywheel, connecting one shaft to another which carries an overhung brake drum, connecting shafts of different diameters, connecting driving shaft to roll or pinion stand when radial clearance is insufficient for standard coupling, and combined with a magnetic or pneumatic clutch coupling. *Farrel-Birmingham Co, 344 Vulcan St, Buffalo, N. Y.*

Caulking Compound

PETROSEAL is compound made to fill need for oil-resisting electrical caulking material for transformer and oil-switch bushings and covers. Compound is described as a non-hardening, adhesive plastic compound which will not slump or flow, dry out or check. Said to adhere readily to any clean, dust-free surface, yet can be easily removed and salvaged. Has good dielectric strength and is not injurious to workers' hands. *Johns-Manville, 22 East 40th St, New York, N. Y.*

Generator Fire Protection

CONSISTS of special shielded nozzles for discharge of carbon dioxide into ventilating ducts of generators in event of fire. As shown, shielded nozzles are affixed to both initial-discharge and delayed-discharge pipes which carry carbon dioxide from storage cylinders to ducts. Common type of installation provides initial discharge of gas to stop rapid combustion of insulation immediately, with delayed discharge fed into ventilation ducts throughout period required for stopping machine to permit extinguishing of all possible glow. Manual control is normally combined with detectors inside generator housing and of differential relays to provide fully automatic release of gas at first sign of fire. *Walter Kidde & Co, 140 Cedar St, New York, N. Y.*



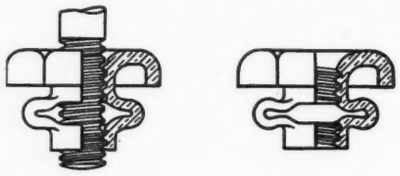
Frequency Meter

VIBRATION FREQUENCY METER, weighing only eight ounces, is designed to aid engineer in ferreting out causes and cures of troublesome machine vibrations. Instrument is no larger than engineers' slide rule, but can indicate frequencies between 500 and 20,000 cycles per minute. Compact device is built around principle of vibrating reed and consists of thin spring steel vibrator clamped at one end between

a set of rollers. Knurled knob connected to rollers permits their rotation and moves steel reed in or out, changing its frequency of vibration. Sliding pointer on back end of steel reed indicates vibrating frequency which is read off calibrated scale on frame of instrument. Photo shows meter being used to determine frequency of frame vibration on small motor frame. *Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

Lock Nut

BOOTS self-locking wing-style nut is said to present all advantages of solid-type nut, but weighs less and cost less. Drawing at left shows hexagon nut when not in use. At right, nut is in use on screw or bolt,

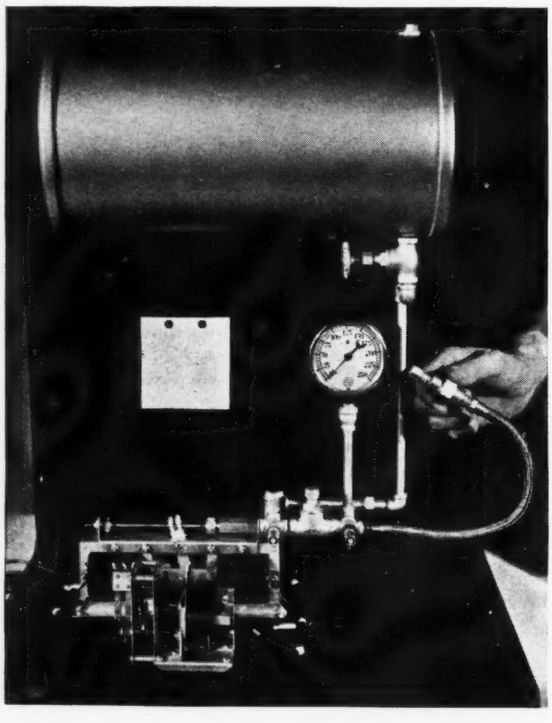


and spring member is expanded to its locking position; threads in nut member pushing up, threads in locking member down. This constant tension locks nut firmly into position, and only wrench applied to nut will loosen or remove it. *Scovill Mfg Co, 99 Mill St, Waterbury, Conn.*

Chemical Injector Pump

SCALE is removed from boilers by pumping unit that injects chemical compounds into hot-water and steam systems. Small variable-speed motor with low current consumption operates constantly in connection with a train of gears, cams and switches, and may be adjusted to control periodical injections. Can also be fitted with metering device which will feed fluids in proportion to other fluids. Solenoids supply power to operate pump, which has sufficient power to send liquid into a boiler against 250-lb pressure. After being

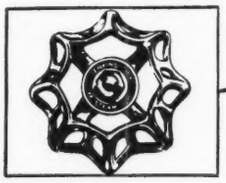
(*Continued on page 142*)



AND YOU'RE THROUGH

SLIP OFF OLD— SLIP ON NEW

Now turn the spindle all the way down and the disc holder will slip off in your hand. Slip on the holder containing the new disc—return the trimming to the body, for "good as new" service.



PERFECT GRIP HANDWHEEL of the non-heat type—designed to prevent contact of hand with a hot wheel nut.

EXTRA DEEP STUFFING BOX contains an exceptional amount of packing—requires less frequent renewal, gives extra protection against leakage.

MORE SPINDLE THREADS mean extra threads in contact with the bonnet—assure extra service, less spindle wear.

HIGH, WIDE SEAT assures maximum seating surface against the disc and permits repeated refacing operations.

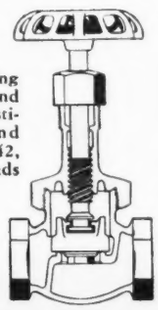
FOR 150-LBS. STEAM OR 300-LBS. O.W.G.

This valve is regularly fitted with Jenkins 119-A Disc, recommended primarily for saturated steam service up to 150 lbs. For recommended discs suitable for handling hot water, cold water, air and gas, gasoline, acids and alkalis, etc., consult the Jenkins Disc Guide.

CAN BE FITTED WITH THE PROPER DISC FOR ANY SERVICE

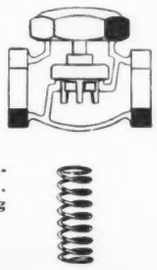
for QUICK OPENING

For services requiring quicker opening and closing, simply substitute this bonnet and spindle from Fig. 942, in which the threads are pitched more sharply.



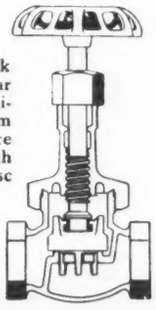
for LIFT CHECKS

Globe and Angle bodies can be fitted with one trimming—Cap, Disc Holder and Disc Holder Nut from Fig. 117-A. For Spring-loaded services . . . simply add Spring from Fig. 655-A.



for STOP AND CHECK

For Stop and Check service, use the regular 106-A trim but substitute this Spindle from Fig. 630-A and replace regular disc nut with the check valve disc nut.



DISCS MADE BY JENKINS

For all these valves, pick the disc *exactly* compounded for the pressure, temperature and fluid to be handled—hot water, cold water, steam, oil, gasoline, air, gas, and other services.

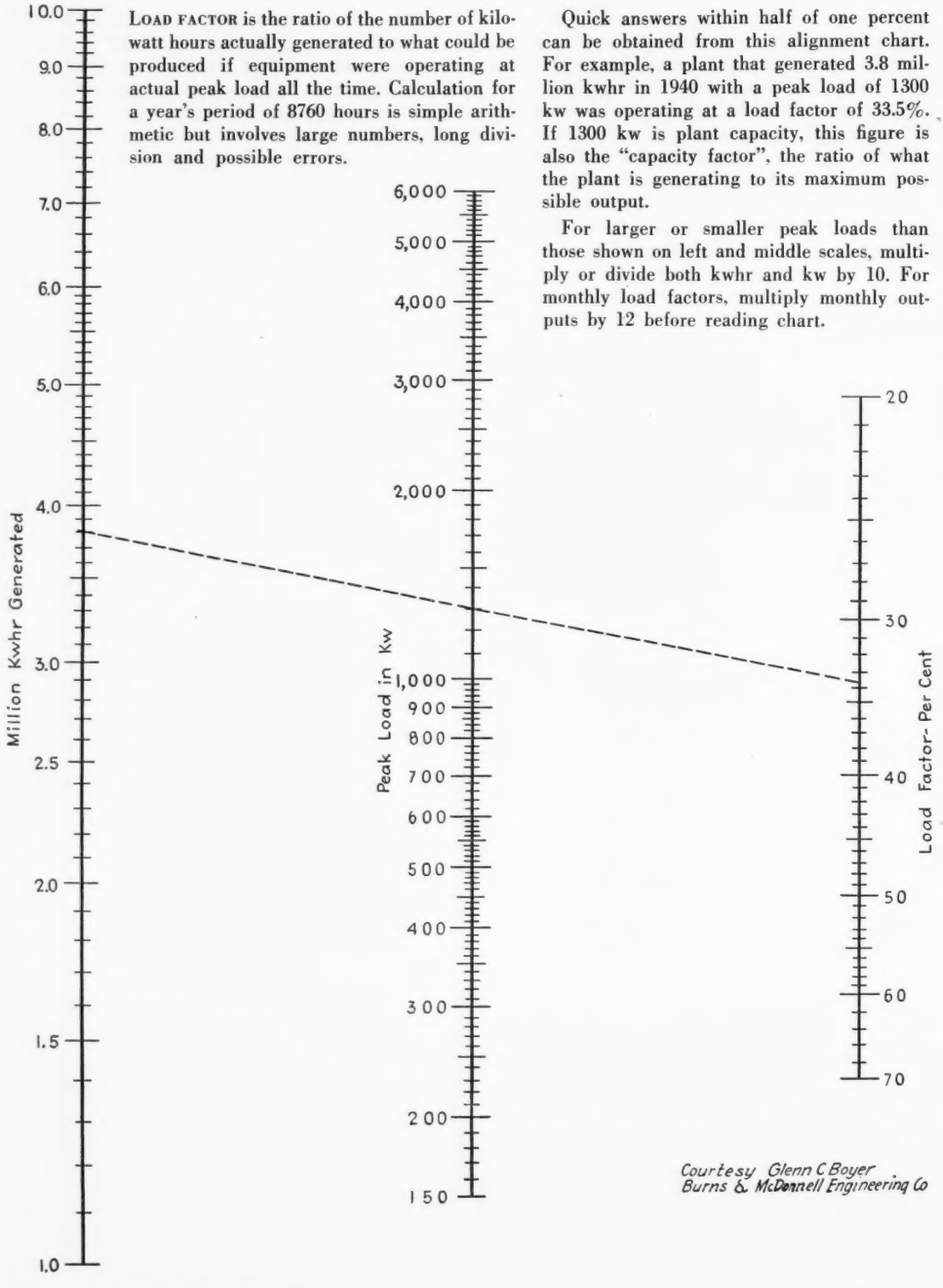
Number 102

Electrical System Load-Factor Chart

LOAD FACTOR is the ratio of the number of kilowatt hours actually generated to what could be produced if equipment were operating at actual peak load all the time. Calculation for a year's period of 8760 hours is simple arithmetic but involves large numbers, long division and possible errors.

Quick answers within half of one percent can be obtained from this alignment chart. For example, a plant that generated 3.8 million kwhr in 1940 with a peak load of 1300 kw was operating at a load factor of 33.5%. If 1300 kw is plant capacity, this figure is also the "capacity factor", the ratio of what the plant is generating to its maximum possible output.

For larger or smaller peak loads than those shown on left and middle scales, multiply or divide both kwhr and kw by 10. For monthly load factors, multiply monthly outputs by 12 before reading chart.

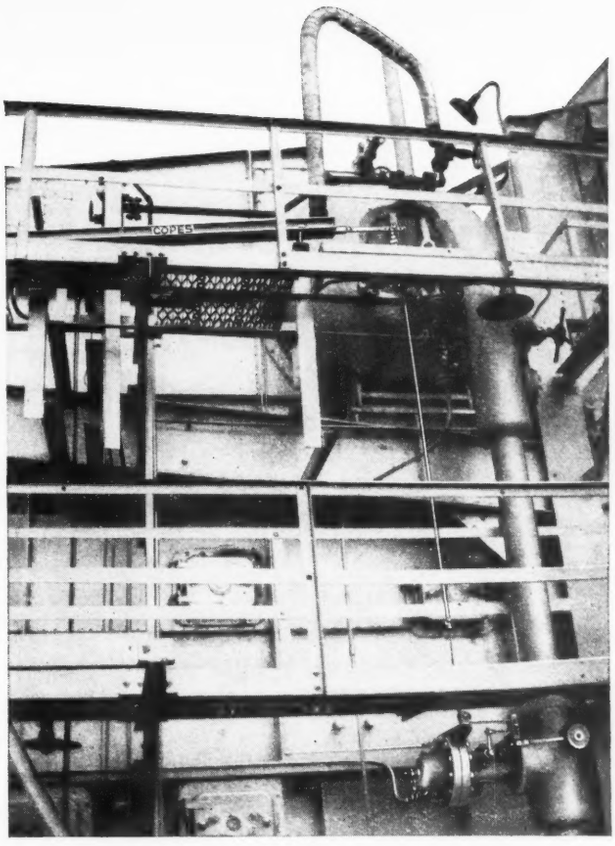


Courtesy Glenn C Boyer
Burns & McDonnell Engineering Co

© POWER

At Fort Bend Utilities Company

This all-outdoor Riley Steam Generator carries a combined utility and sugar plant load. The steam demand fluctuates rapidly and over a wide range. The COPES Flowmatic Regulator, shown in the photograph, was installed and adjusted without need of factory service. There is an extreme water level variation of plus or minus one inch.



For Pressures from 80 to 1900 Pounds

In less than four years, over 300 COPES Flowmatic Regulators have been ordered for important utility and industrial plants. They are to operate at pressures from 80 to 1900 pounds gage—on boilers with steaming capacities from 15,000 to 650,000 pounds per hour. This is the widest, quickest acceptance ever gained by any steam-flow type feed water regulator.

FLOWMATIC helps get new boilers on the line..*quickly!*

ONE thing users like about the COPES Flowmatic is the way it swings into almost-perfect operation from the moment it is adjusted and cut into service. They say this simplified two-element steam-flow type feed water regulator is just about as easy to adjust and operate as a simple level control. They tell how the dependably accurate level control saves them time in getting new steam generating units on the line—because all their efforts can be devoted to coordinating other auxiliaries and controls for efficient plant operation.

Want to know how this new COPES operates—where it is used—what results others are getting in regular service? Then write for Bulletin 429—16 pages of informative illustrations and text.

NORTHERN EQUIPMENT COMPANY
111 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters

★ GET CLOSER LEVEL CONTROL WITH THE COPES FLOWMATIC ★ REGULATOR
FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

POWER LINES

Defense Committee Reports On Training Courses

The New York Committee on Engineering Training for National Defense has prepared and issued a brochure on an inquiry conducted by field representatives of the committee as to the need in the Metropolitan New York area for intensive short-term courses for training men to meet an expected shortage of engineering personnel in industries essential to national defense. Between October 17 and November 4, 1940, 174 firms and associations in 18 groups of industries were interviewed. After a study of company records and reports, the committee drew conclusions and made recommendations, which may be obtained from the committee's headquarters, 29 West 39th St, Room 601, New York, N. Y.

Coal Production Reaches New High

The four-hundred-million-ton mark in the 1940 production of bituminous coal was passed when the cumulative total for the week ending Nov 23, on basis of preliminary figures, reached 402,127,000 tons. This was more than total output for 1939 and was larger by more than 50 million tons than the 1938 output.

"With five weeks remaining this year and production in excess of nine million tons weekly, the 1940 total may be expected to reach and perhaps exceed the 446-million-ton total of 1937", said John D Battle, executive secretary of National Coal Association.

At the same time it was reported by Director Howard A Gray of the Bituminous Coal Div, Department of the Interior, that more than 1000 coal producers have joined the Bituminous Coal Code since minimum prices became effective on October 1, 1940. This brings up to 13,573 the number of producers participating in the market-stabilization program set up under the coal act.

When they join the code, producers become exempt from the 19½% tax which the Coal Act levies on sale of coal. However, they may not sell their coal at less than the minimum prices without risking loss of code membership and penalties under the law. Producers who are not code members must pay tax, but may sell coal at any price suitable to them.

Air-Conditioning Association to Meet in Chicago, Jan 13

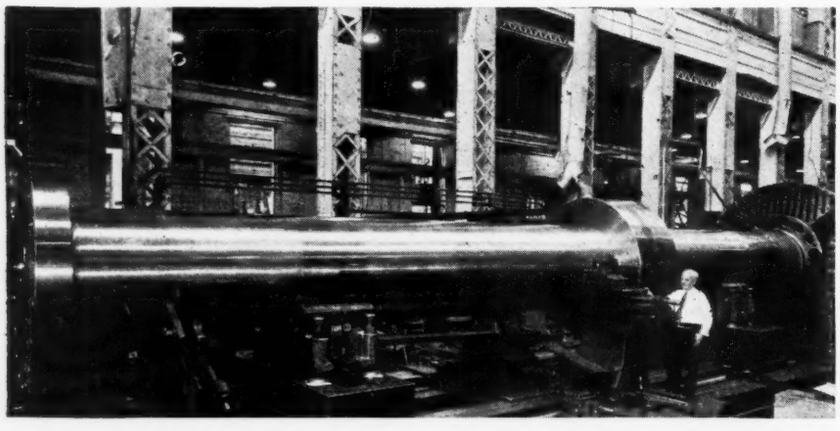
The 1941 convention of the National Air Conditioning Association will be held at the Blackstone Hotel in Chicago, Ill., January 13, 14, and 15. Tentative plans for the convention were laid down and measures for immediate expansion of the association's membership and general program were discussed at a preliminary meeting on November 2, 1940. Important agenda now being prepared for consideration at the convention include revision of the association's by-laws which has been undertaken in the light of experience gained since organization's first convention last January.

ASHVE Meeting Program Rapidly Taking Shape

Program for the Kansas City meeting of the American Society of Heating and Ventilating Engineers is rapidly being prepared by local chapter of the organization. The 47th Annual meeting will be held January 27 to 29 at the Hotel Muehlebach, Kansas City, Missouri.

The program committee has arranged four technical sessions and offers a varied group of subjects for discussion. These include: Studies of Friction in Fluid Flow; Comfort and Health and Temperature—a Mathematical Solution; Reheating by Means of Refrigeration Compressor Discharge Gas; Radiation as a Factor in Comfort Requirements, and a discussion of codes affecting boilers, furnaces and stokers. In addition, the Committee on Arrangements is preparing an attractive program of entertainment for delegates and ladies.

SHAFT FOR GRAND COULEE



Workman checks alignment of turbine and intermediate shafts of 150,000-hp hydraulic unit for Grand Coulee, at shops of Newport News Shipbuilding and Dry Dock Co. Statistics on this gigantic shaft are: nominal diameter, 44 in.; coupling diameter, 75 in.; length, 42 ft; weight, 125 tons

POWER's History

POWER was founded in 1884 by E P Harris and H M Swetland. With it was incorporated *Steam*, which had been started by N Hawkins in Chicago two years earlier.

In 1903 POWER purchased and absorbed *Science and Industry*, which was a consolidation of a number of periodicals, namely, *Home Study Magazine, Home Study for Machinists, Mechanic's Magazine, Home Study for Building Trades, Building Trade's Magazine, Home Study for Electrical Workers and Steam Electric Magazine.*

In 1908 POWER absorbed *The Engineer's Review*, of Cleveland, and *The Engineer*, of Chicago, the latter being a consolidation of *The Safety Valve, Lord's Power and Machinery Magazine, The Stationary Engineer, Steam Engineering and The Mechanical Engineer.* When *The Engineer* was purchased, the name of the combined magazine was *Power and the Engineer.* The title was condensed to POWER in 1911. All rights to the above titles reserved.

OBITUARIES

WILBERT J AUSTIN, president of the Austin Co, of Cleveland, who was among the victims of an airliner crash at Chicago, December 4, had been the head of that organization since 1924. A native of Cleveland, where his father, Samuel Austin, set up as a journeyman carpenter on arrival from England, Wilbert Austin was graduated from the Case School of Applied Science in 1899, with a Bachelor of Science Degree in Mechanical Engineering. In March, 1940 the school awarded him an honorary degree of Doctor of Engineering. While at time of his death he was not active as general manager, he was devoting his principal attention to construction needs in the present defense emergency.

JOHN P CLANS, 77, chief engineer of the National Biscuit Co, in Buffalo, N. Y., for 38 years, died at his home there Nov 10, 1940. Mr Clans was chief engineer for the National Biscuit Co since it was the old Ovens Bakery. He planned and put into operation the machinery at present Buffalo plant when the company moved there and took the National Biscuit Co

(Continued on page 162)

When re-tubing your condenser or heat exchanger...

Look first to Anaconda

You'll find a complete range of tube alloys and a staff of experienced technicians whose consultation entails no obligation . . .

There is such a complication of operating factors having an influence on the service life of condenser tubes that no one tube alloy can possibly solve all problems.

To determine the tube alloy that will give the greatest service per dollar of cost requires metallurgical experience and practical knowledge of specific operating conditions. So we suggest that you take advantage of the experience of our Technical and Engineering Departments. They can place before you performance records of copper alloys under operating conditions similar to your problem. No charge is made for such consultation.

☆ ☆

ANACONDA TUBE SHEETS—We produce a complete line of plates and circles for marine and stationary condensers, heat exchangers, feed water heaters and oil coolers. The same careful technical supervision used to control the manufacture of Anaconda Condenser Tubes is given this material during the entire process of production. 41111

Here is one of the most complete books on the subject of tube alloys for condenser and heat exchangers in marine and stationary steam power plants. In its 60 pages you will find real down-to-earth information which you can put to practical use. A free copy is yours for the asking.

ANACONDA

Anaconda Condenser Tubes

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • *Subsidiary of Anaconda Copper Mining Company*

Sowing the Wind . . .

FORCED either by tight-fisted bosses or their own short-sightedness, many power engineers for years have been buying cheap refractories, packings, gaskets, lubricants, and similar supplies. It means repacking stuffing boxes, rebuilding furnaces, and refitting bearings just that much oftener, but there has been plenty of time available for that. Loads haven't begun to take all the available capacity —and there have always been weekends and holidays.

But all that has suddenly changed. More and more plants are working three shifts every day of the week; more and more power plants are being forced to stay on the line with every unit they've got. New units may be on order, but delivery is something else again. Time out for maintenance means lost production.

One engineer after another is learning the folly of being penny-wise and pound-foolish. Power-plant penny-pinching economies of the last several years have been backfiring, raising the very devil with factory production. *Now*, only the best of materials are going in, for taking time out to replace short-life "economical" materials just can't be tolerated.

To the engineer who's in this spot, my warning comes too late. But to you others who see busy times coming (and that means almost all industrial-plant men), I suggest immediate checkup and repair with first-grade materials. Make your plant able to take it when it must! Any other policy is just sowing the wind of bad judgment that reaps a whirlwind of trouble later on.

George Edwards
Engineer

It takes ONLY ONE DAY for ANY SPECIAL SHAPE

when you cast it in your own plant with J-M FIRECRETE CASTABLE REFRACTORIES

24 hours after a shape is needed, it's in service!

Fast work? Yes—but it's typical of the results you can enjoy by casting your own special shapes with J-M Firecrete.

Briefly, here's why. Firecrete is mixed, handled and poured like ordinary concrete. It casts easily, sets quickly, has no drying shrinkage. And, on the job, its great resistance to spalling assures long, economical life.

It's almost impossible to tell when a special shape will be needed. Why carry expensive stocks —or take chances of long delays in shipment? Just keep on hand the J-M Castable Refractories best suited to your requirements and cast whatever shapes you need in your own plant.

Furnished in 100-lb. bags, J-M Castables are stocked by distributors throughout the country. For the name of the one nearest you, write Johns-Manville, 22 East 40th Street, New York, N. Y.

● Mixed and cast like ordinary concrete, J-M Firecrete enables you to make your own special shapes quickly, easily and at low cost.

J-M Castable Refractories that will Save You Time and Money . . .

For temperatures up to 2400° F.—Standard Firecrete. Ideal for furnace doors, baffles, kilns and waste heat flues, poured linings, some types of combustion chambers. No drying or firing shrinkage up to 2400° F. 110 lbs. required per cu. ft.

For temperatures up to 2800° F.—H.T. Firecrete. Similar in properties and uses to Standard Firecrete, but has considerably higher heat-resistance for use up to 2800° F. 115 lbs. required per cu. ft.

For temperatures up to 2200° F.—L.W. Firecrete. Lighter in weight and lower in conductivity and heat-storage capacity than Standard Firecrete. Recommended for doors and for casting small intermittently fired furnaces, furnace bottoms and special shapes where these qualities are important. 65 lbs. required per cu. ft.

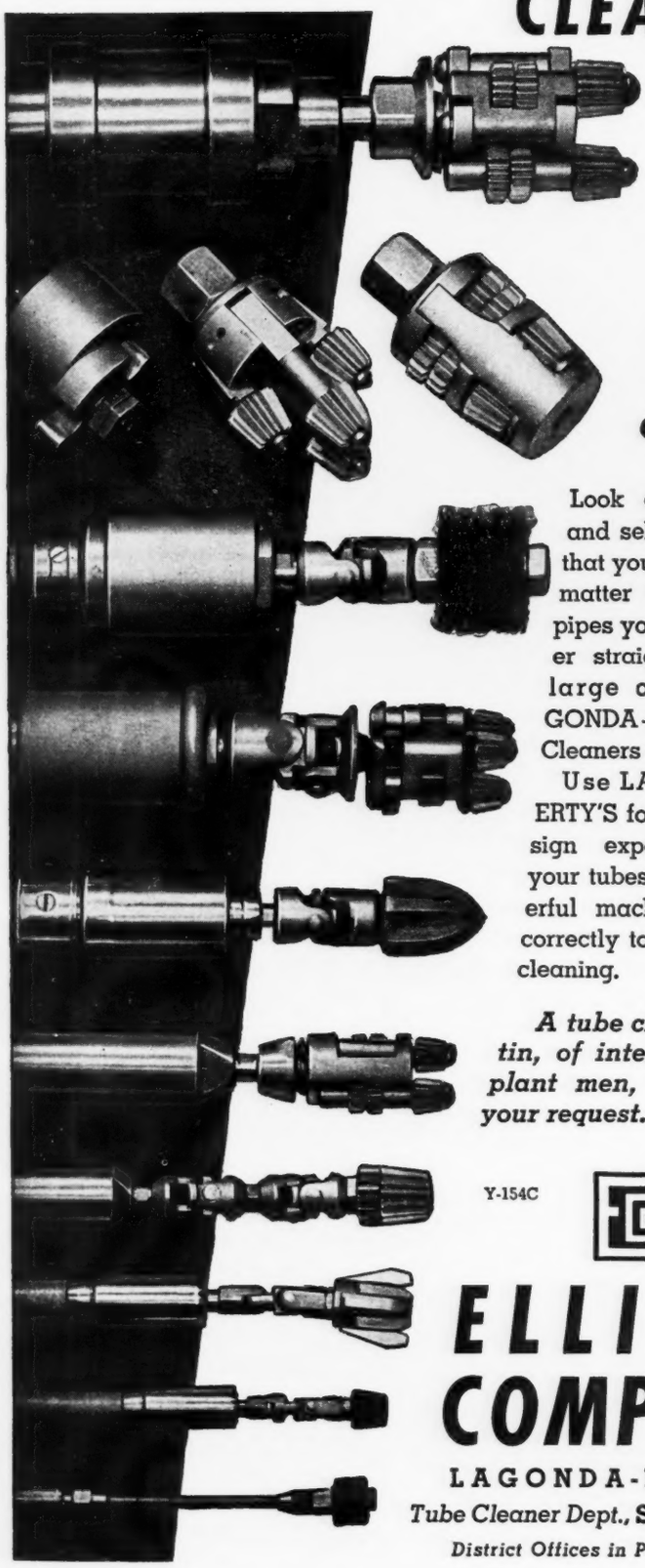
For temperatures up to 3200° F.—J-M Chrome Castable. Designed particularly for use in forging and heat-treating furnace bottoms where it effectively resists the action of iron scale. Ideal also as a slag-resistant base for billets. 180 lbs. required per cu. ft.

JM Johns-Manville CASTABLE REFRACTORIES

Standard Firecrete . . . H. T. Firecrete . . . L. W. Firecrete . . . J-M Chrome Castable

AVAILABLE ON PHONE CALL AT YOUR NEAREST DISTRIBUTOR

Clean any tube with LAGONDA LIBERTY CLEANERS



Look down the line and select the cleaner that your job needs! No matter what tubes or pipes you have—whether straight or curved, large or small—LAGONDA-LIBERTY Tube Cleaners can clean them. Use LAGONDA-LIBERTY'S forty years of design experience. Clean your tubes with fast, powerful machines equipped correctly to do your job of cleaning.

A tube cleaning bulletin, of interest to power plant men, is ready for your request.

Y-154C

ELLIOTT COMPANY

LAGONDA-LIBERTY

Tube Cleaner Dept., **SPRINGFIELD, O.**

District Offices in Principal Cities

Breakers Blast Circuits

(Continued from page 67)

lengthens the arc by driving it in between the barriers. The interrupting action is very much the same as with the oil blast; namely, the air stream carries the arc products away so that at current zero there is clean air under pressure between the stationary and moving contacts. That air has adequate insulation to resist the recovery voltage and cause interruption in less than one cycle at 15,000 volts.

Air-blast breakers are available for 15,000-volt service in interrupting ratings 500,000 kva to 2,500,000 kva. They require no more space than do oil circuit breakers of corresponding ratings.

Magne-Blast Type

When the contacts *C* separate in the Magne-blast breaker, Fig. 8, the arc formed is driven into a chute of insulating material by blow-out coils *B* not normally in the circuit but cut in as the contacts part. The chute in which the arc is driven is designed to lengthen and cool the arc. In Fig. 8, one-half of the chute is removed. The other half also has leaves which are so located that when the two halves are together the leaves of one half alternate with those of the other, as in section *CC*, Fig. 9. These leaves are shallow at a point adjacent to the contacts, section *AA*, but deepen as they extend away from the contacts.

The arc formed at the contacts is driven deeper and deeper into the chute by the blow-out coils. Due to the interleaving arrangement of the leaves, the arc must follow a serpentine path and is greatly lengthened as it moves outward in the chute. This lengthening, together with the cooling action from contact with the surface, increases the resistance of the arc path, thereby reducing the magnitude of the short-circuit current and bringing the power factor of the circuit nearer unity. The latter effect reduces the rate of rise of the recovery voltage to a point where it is insufficient to break down the insulation in the arc path and interruption occurs. Magne-blast breakers are built for indoor service in interrupting ratings up to 150,000 kva at 5000 volts.

Arc-control devices of the blast-type herein described have the characteristics of interrupting the circuit very quickly. They provide the advantages gained from less oil deterioration, in the case of oil breakers, and minimum contact burning in all cases.

BETZ SERVICE

INCLUDES

BOILER FEEDWATER
PROCESS WATER
MUNICIPAL SUPPLY WATER
WASTE DISPOSAL—RECLAMATION

PLANT STUDIES
PLANT DESIGN
CONSULTATION
SUPERVISION

Some folks take their celebrations too seriously,—hence the Water Wagon as a time honored symbol of the New Year resolution. On the other hand, some people don't take their headaches seriously enough and their water problems become a perpetual headache. Every year, however, finds hundreds of Plant Executives seeking a definite solution of their water problems, and turning to the chemical engineering service offered by Betz.

Start the New Year right, right now! Assure yourself and your plant personnel, a Happy New Year throughout 1941, in-so-far as your water and steam is concerned. Follow the trend of the field, toward the best available service for water conditioning—Betz Service. When you think of water, think of Betz!

• The BETZ INDICATOR is mailed without charge to Plant Executives—9000 every month. Write for your FREE copy.

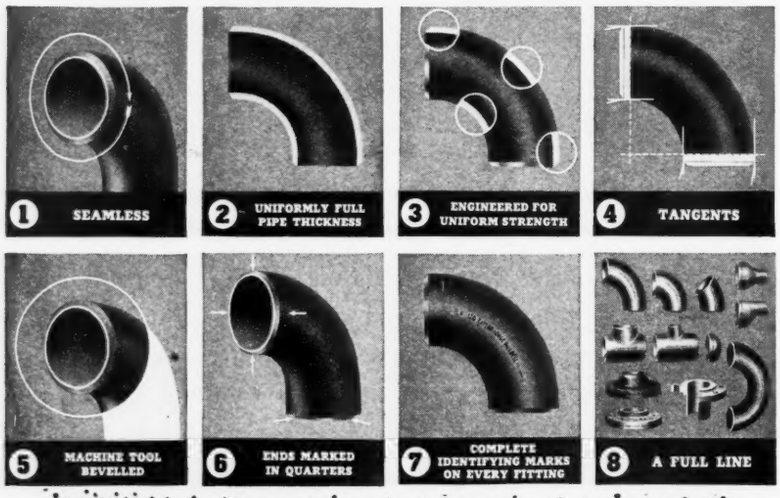
CABLE ADDRESS: BETZPHIL : BENTLEY CODE

W. H. & L. D. Betz

Chemical Engineers and Consultants on All Water Problems

General Offices and Laboratories at 235 W. Wyoming Avenue, PHILADELPHIA, PENNA. • *Branch Offices at* 50 Church Street, NEW YORK • 37 W. Van Buren Street, CHICAGO • 506 Dime Bank Bldg., TULSA • Betz Laboratories Division, Wood Industries, Ltd., Royal Bank Bldg., MONTREAL • 906 New Wellington Bldg., TORONTO

Why be satisfied with "just-as-good" welding fittings? WeldELLS alone offer you all these 8 aids to faster, easier pipe welding.


1 SEAMLESS
2 UNIFORMLY FULL PIPE THICKNESS
3 ENGINEERED FOR UNIFORM STRENGTH
4 TANGENTS
5 MACHINE TOOL BEVELLED
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Three Years' Experience Burning Wood Waste

(Continued from page 99)

diation of the wood fire without damage to the burner parts.

As might be expected, combustion becomes more active when wood refuse contains a large proportion of fines up to a point where ignition takes place directly at the inlet boxes. Considerable quantities of wood burn in suspension before reaching the furnace floor but experience shows that with this arrangement, the accumulation on the floor is needed to maintain ignition when burning wood alone. Operators maintain the contour of the mass to resemble an underfeed stoker bed, by adjusting dampers in the secondary air ducts.

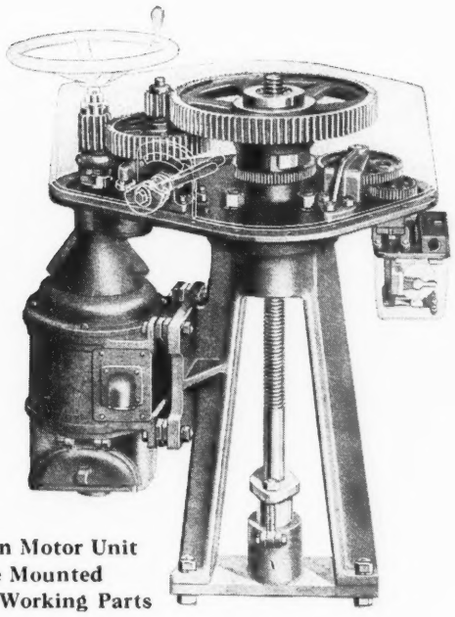
Operation of System

Operation of the wood-burning system is simple and the only hand operation required, other than occasionally changing the positions of the secondary dampers, consists of operating the switches on the boiler panel controlling amount of wood fed to the boilers. This requires but little attention as experience has shown the firemen the exact number of batteries of feed screws in the storage bin that should be in operation for a particular steam load. Burning-back in the 6-in. conveyor line has never been experienced.

The second boiler, placed in operation in 1938, resembles the first except that it is opposite hand. The operation of this boiler and all auxiliary equipment has been just as satisfactory as the first. Recently one boiler operated for a period of three months, under all loads, with wood refuse alone as fuel except that burning a small amount of coal fired each morning tides over the period when the factory starts up and the supply of wood becomes available. Boilers have also been fired with different proportions of pulverized coal and wood and no difficulty has been experienced from interference between fuels.

Samples of flue gas yield an analysis of 12 to 13% CO_2 when burning wood refuse only; 14 to 15% when burning pulverized coal only; and 13 to 14% when burning the fuels in combination. Higher readings have been obtained but the above figures are based on average operation under normal steam loads.

VALVES BE SEATED!



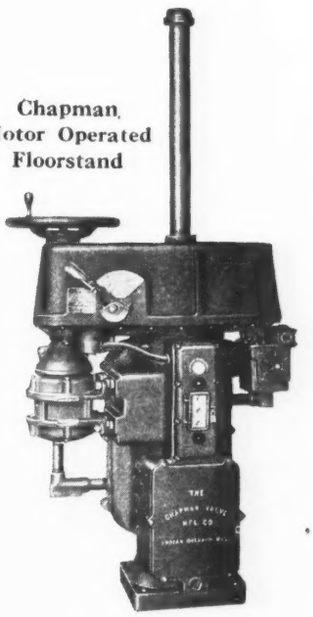
Chapman Motor Unit
Yoke Mounted
Showing Working Parts

and do it the positive "jam-less" way with

Chapman Motor Units

The use of Chapman Motor Units in waterworks and filtration is widespread and increasing. There must be and *are* good reasons. These units have many unique features which insure positive, dependable control. They are available in various mountings, including floorstands, each a complete, factory-wired unit with push button control and manual control instantly available. One *outstanding* feature is the micrometer-adjusted Chapman Limit Switch, which controls seating to any pre-determined tightness and eliminates "jamming". This and many other notable features make the Chapman Motor Unit outstanding for all types of motorized valve control.

Write for Bulletin describing the Chapman Motor Unit



Chapman
Motor Operated
Floorstand

THE CHAPMAN VALVE

Manufacturing Company

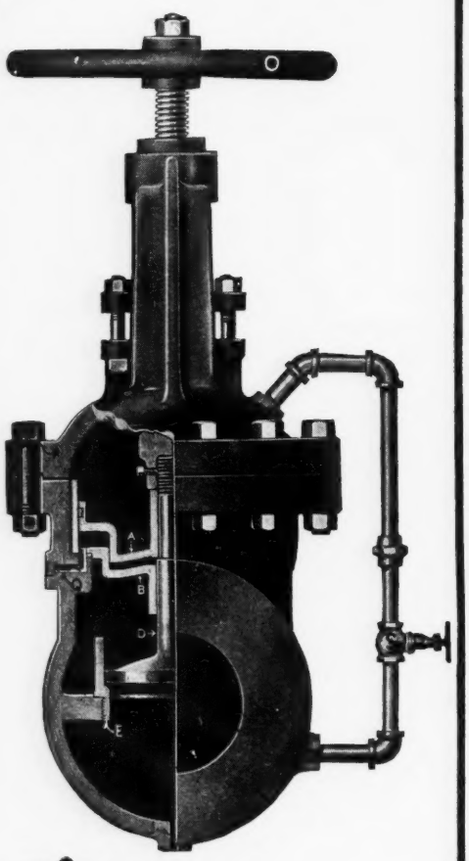
INDIAN ORCHARD, MASS.

GOLDEN-ANDERSON

Specialty

VALVES

THROTTLE AND EMERGENCY STOP



● With G-A's throttle and emergency stop valve, you're assured of protection against damage to valuable property, for it automatically shuts down any overspeeding engine or turbine. It works instantly . . . mechanically, electrically, or by hand . . . even to being tripped by a push button from remote points. No unit can exceed safe operation speed when equipped with this valve, as maximum speeds are rigidly controlled. Comes in angle and globe patterns from 2½" to 16" in size. You'll find these quality G-A valves in use, under every pressure, on all types of steam engines and turbines. For a more detailed description of the complete G-A line, write for our free catalog today.

Also

Triple Acting Non-Return . . .
Altitude Control . . .
Float Control . . .
Pressure Reducing . . .
Check Valves, etc.

Golden-Anderson Valve Specialty Co.

Fulton Bldg. • • • Pittsburgh, Pa.

New Plant Equipment

(Continued from page 128)

reduced to a powder by solvent, scale passes out through waste line. Special chemicals used are non-poisonous and will not injure gaskets or metal, and unit will pump other liquids, including oil or water. *James Research Laboratories, Chicago, Ill.*

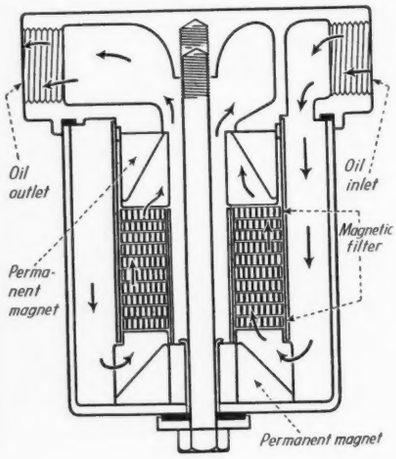
Electronic Level Control

PHOTOSWITCH level control is available for both conductive and non-conductive fluids and powders. For 2-level control, electrodes are attached to tank at levels representing low point where pumping starts, and high level, where pumping stops. These electrodes are wired to level con-

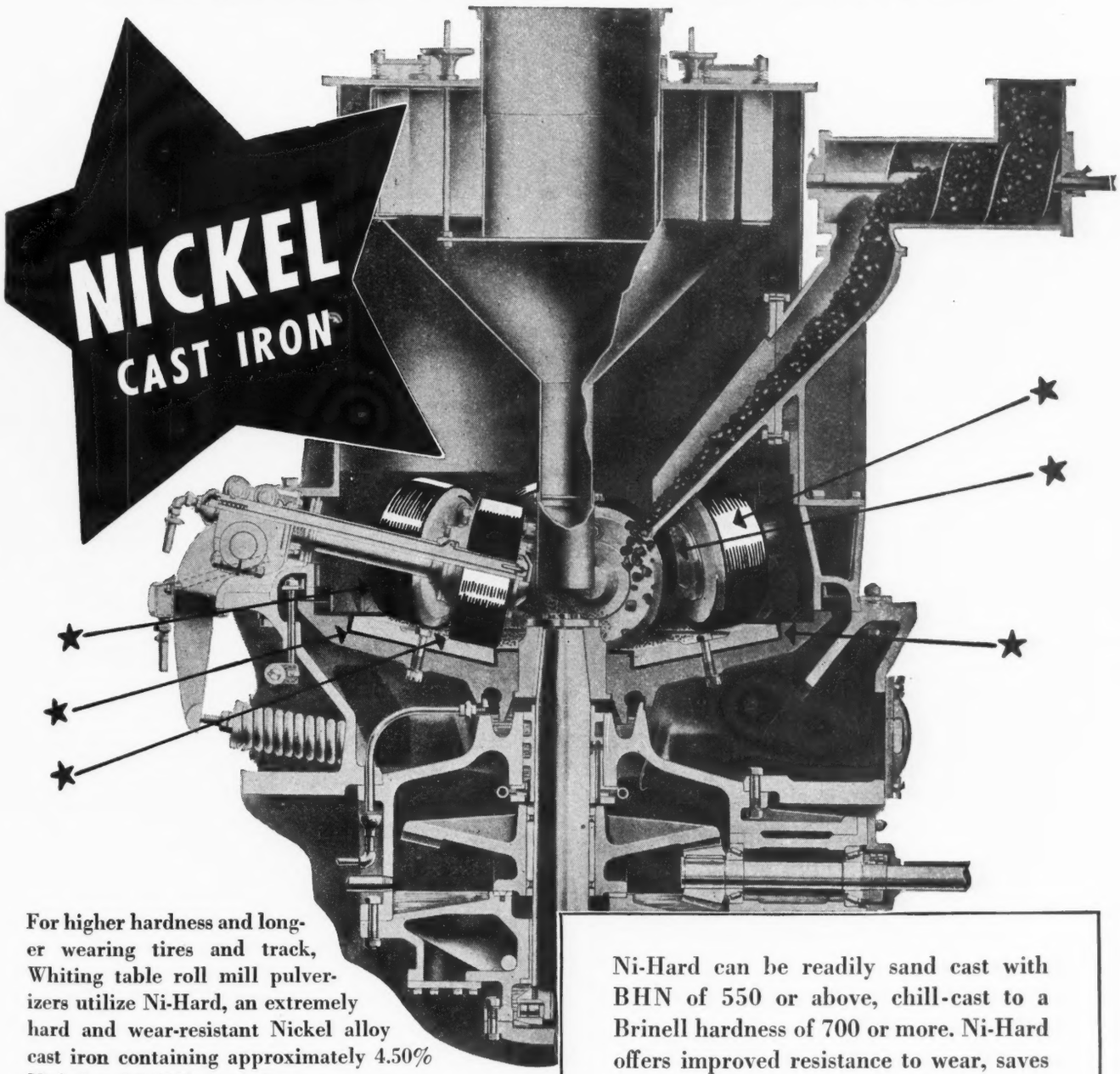
trol. When liquid falls below lower electrode, level control closes circuit which starts pump, and tank fills. When tank-level rises to upper electrode, fluid itself acts as conductor of small amount of current needed for operation of level control. This opens pump control circuit. *Photoswitch, Inc, 21 Chestnut St, Cambridge, Mass.*

Magnetic Filter

FRANTZ FERRO FILTER now made with permanent magnet, as addition to line made with electromagnet. Claimed to extract magnetically coarse and small iron particles from suspension in lube-oil circulating systems at no operating or maintenance cost. Consists of a stack of magnetic



TRUSTY NI-HARD* SERVES LONGER TIME!



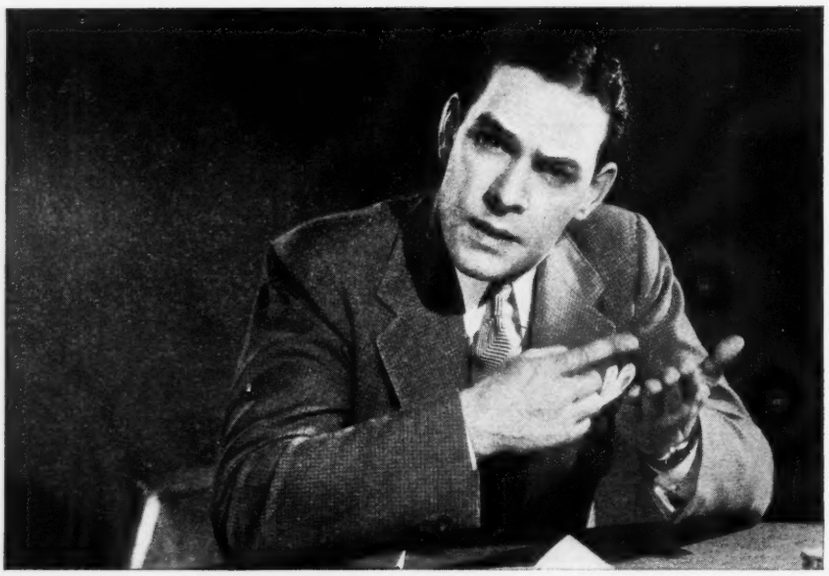
For higher hardness and longer wearing tires and track, Whiting table roll mill pulverizers utilize Ni-Hard, an extremely hard and wear-resistant Nickel alloy cast iron containing approximately 4.50% Nickel and 1.50% chromium.

Crushing thousands of tons of abrasive materials to a uniform fineness wears down any pulverizer. But Whiting engineers have markedly reduced maintenance costs on liners, rollers, and tables by depending upon the exceptional wear resistance of Ni-Hard.

Ni-Hard can be readily sand cast with BHN of 550 or above, chill-cast to a Brinell hardness of 700 or more. Ni-Hard offers improved resistance to wear, saves money in process industry applications by serving longer between replacements. Your inquiries regarding Ni-Hard applications will be promptly answered.

*Ni-Hard—Reg. U. S. Pat. Off. by The International Nickel Co., Inc. 281,986.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK, N. Y.



WHY PAY 800% MORE?

Every time you replace a worn Bronze Gate Valve with a new one, you are paying about 800% *more* for that new valve than it would cost to repair a Fairbanks Renewable Bronze Gate Valve. For when the Fairbanks seat rings wear, they can be replaced for about 10% of the original cost of the valve . . . then the valve is as good as new.

Fairbanks Renewable Valves

also save time, labor and expense by enabling you to make renewals in a few minutes without removing valves from the line or disturbing pipe coverings.

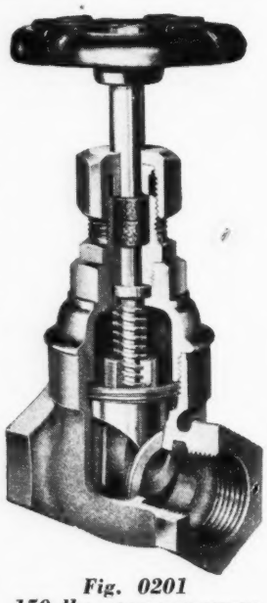


Fig. 0201
150 lbs. steam pressure

Why not stop this deplorable waste now by replacing worn valves with Fairbanks "Renewables"? They're made in bronze and iron, in types and sizes to meet practically every requirement. Write today for Catalog No. 21 and name of our nearest distributor.

THE FAIRBANKS COMPANY

Valves, Dart Unions, Hand Trucks and Wheelbarrows

397 Lafayette St. New York, N. Y.

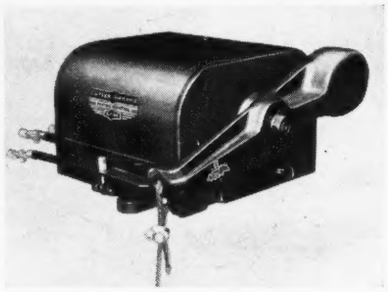
Boston, Mass., Pittsburgh, Pa.—Distributors in Principal Cities

Factories: Binghamton, N. Y., Rome, Ga.

screens or filters, see illustration, mounted on tube, held in by permanent magnet on each side. Unit is mounted close to engine and becomes a part of circulating lube oil system. Although offering little resistance to flow, their design presents hundreds of feet of strongly magnetized edges to oil. These edges comb and recomb oil and magnetic particles are held firmly by screens until cleaned. *S G Frantz Co, Inc, 161 Grand St, New York, N. Y.*

Crane Limit Stop

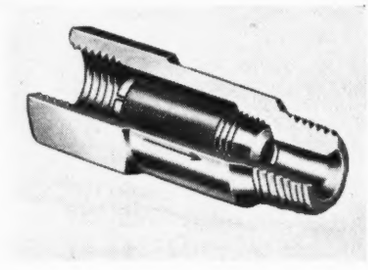
MAIN CIRCUIT crane safety-limit stop prevents overtravel of crane hook when hoisting. Device is operated by counter-weighted lever and suspended reset weight, see illustration. As hook approaches its limit of travel, reset weight is raised, thus allowing counterweight to trip switch. Quick



make-and-break mechanism opens normally-closed power contacts to disconnect motor from line and closes another set of contacts to connect a resistor across motor circuit, establishing smooth, quick braking. When limit stop is in tripped position, bypass circuit is established which permits backing out of limit at slow speed. *Cutler-Hammer, Inc, Milwaukee, Wis.*

Strainer

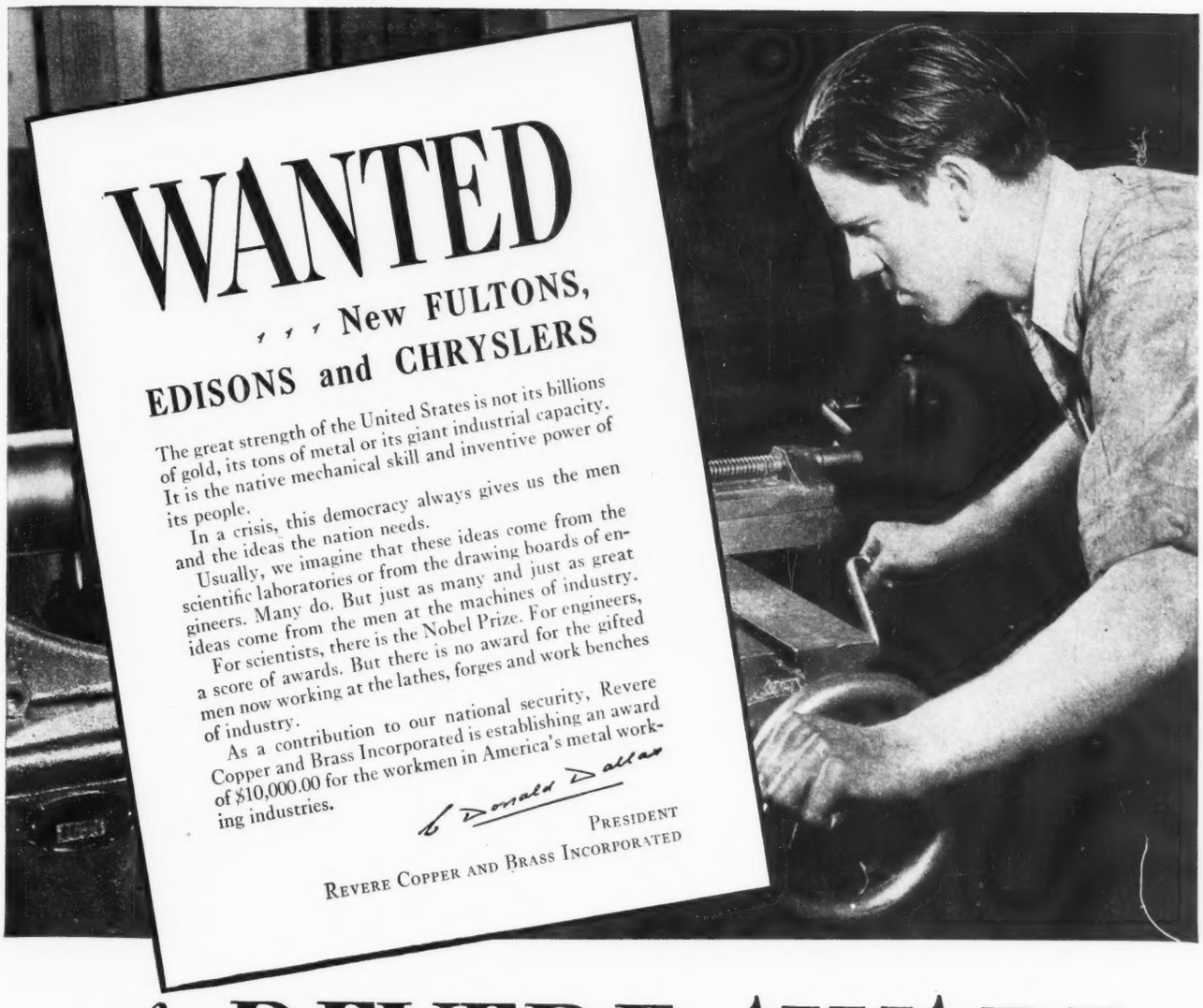
STRAINER for use with spray nozzle when foreign matter interferes with efficient operation is equipped with ¼-in. pipe con-



nection for inlet and outlet. Standard stock construction is brass with Monel metal strainer, although other materials and sizes can be supplied. *Spraying Systems Co, 4201 W Lake St, Chicago, Ill.*

Air-Operated Humidifier

AIR-OPERATED STEAM-TYPE HUMIDIFIER is intended for installations where electric circuits are undesirable. As shown by diagram, assembly includes a pneumatic hygrostat which acts as pilot valve to admit


WANTED
. . . New FULTONS,
EDISONS and CHRYSLERS
The great strength of the United States is not its billions of gold, its tons of metal or its giant industrial capacity. It is the native mechanical skill and inventive power of its people.
In a crisis, this democracy always gives us the men and the ideas the nation needs.
Usually, we imagine that these ideas come from the scientific laboratories or from the drawing boards of engineers. Many do. But just as many and just as great ideas come from the men at the machines of industry.
For scientists, there is the Nobel Prize. For engineers, a score of awards. But there is no award for the gifted men now working at the lathes, forges and work benches of industry.
As a contribution to our national security, Revere Copper and Brass Incorporated is establishing an award of $10,000.00 for the workmen in America's metal working industries.
Donald Dallas
PRESIDENT
REVERE COPPER AND BRASS INCORPORATED

The REVERE AWARD

of $10,000 for Wage Earners in America's Metal Working Industries

THE Revere Award is made by Revere Copper and Brass Incorporated to help speed national defense by encouraging the mechanical genius and inventive talent of American wage earners.

The Revere Award totals $10,000.00 divided as follows:

1st Award	$5,000.00
2nd Award	2,500.00
3rd Award	1,000.00
4th to 9th Awards	250.00 each

The Revere Award is open to all wage earners (foremen and workingmen) in the metal and metal-working industries and to all machine maintenance men.

Each entry remains the property of the sender.

Selection will be made by an impartial Jury of Award consisting of men high in science, labor, the Army, the Navy and industry. The decision of the Jury of Award will be final.

Winners will be chosen for the inventions, devices, improvements or ideas which, in the Jury's opinion, contribute most to speeding up America's Defense Program.

It is desired that all entries be placed at the command of the Defense Advisory Council at Washington, D. C., subject to the entrant's own written consent.

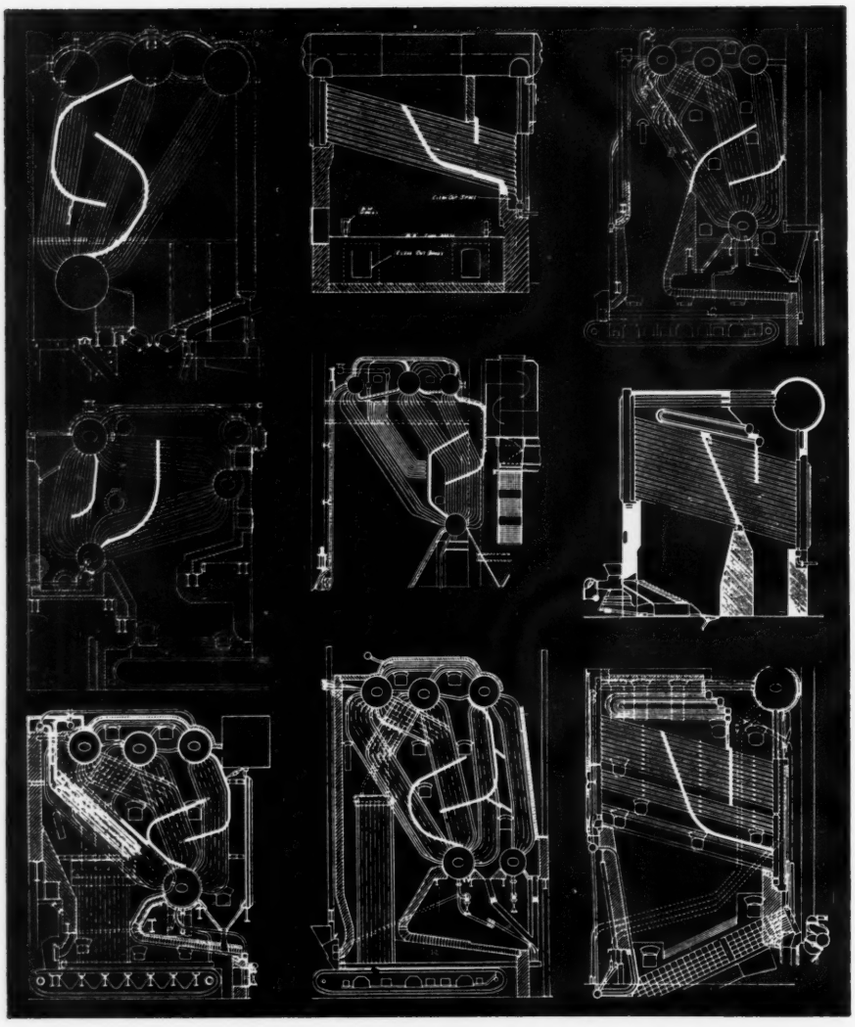
Two or more men may cooperate in any entry.

Entries close on midnight, April 30th, 1941.

For booklet giving complete details of The Revere Award and for Entry Blanks simply write to THE REVERE AWARD COMMITTEE, P. O. Box 1805, Washington, D. C.

★ ★ ★ ★ ★

Enco Streamline Baffles



YOU CAN INCREASE CAPACITY AND EFFICIENCY IN EXISTING OR NEW BOILERS

Installation of ENCO Baffle Walls in all types of water tube boilers has resulted in immediate improvement in performance, operation and maintenance.

Better heat distribution, maximum heat transfer to boiler and superheater surfaces, lower draft loss, lower flue gas temperatures and higher capacity are assured through ENCO design and construction. In addition, the smoothly curved surfaces of ENCO streamlined baffles tend to prevent fly ash and cinder accumulation, saving time and steam by making it easier for soot blowers to do a more thorough and efficient job of keeping heating surfaces clean.

ENCO Baffles, constructed gas tight with Enco Plastic, Tile and Reinforcement provide for expansion and assure extra strength. They may be built in desired locations assuring minimum disturbance when tube renewals are required.

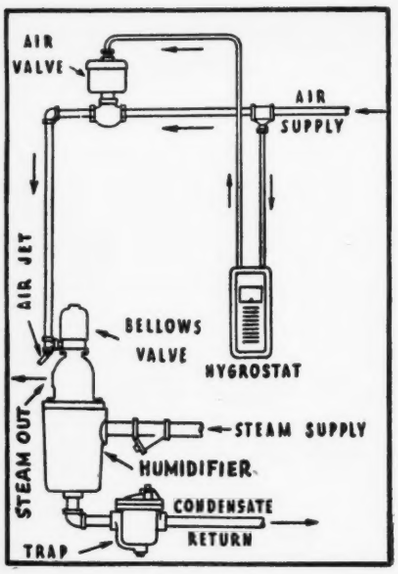
Flexible design, the careful selection of materials and their installation by experienced mechanics result in a construction which can be depended on for long service under severe operating conditions.

TAKE ADVANTAGE OF **ENCO SERVICE** TO IMPROVE YOUR BOILERS

Send blue prints and operating data and ask ENCO engineers to submit suggestions. No obligation, of course. Ask for the new Enco bulletin BW 40—sent FREE on request and containing detailed engineering information on modern ENCO Baffle walls for all types of water tube boilers. Write for your copy **TODAY.**

THE ENGINEER COMPANY

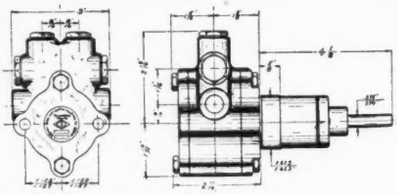
75 West St., New York, N. Y.



pressure to diaphragm chamber of main air valve when relative humidity drops below desired percentage. Opening of main valve allows compressed air to flow to humidifier when pressure builds up and opens a steam valve in top of humidifier. Steam valve admits steam to special silencing chamber in humidifier, from which it escapes directly to atmosphere to add humidity to room. To insure dryness of steam released by humidifier, entire silencing chamber is jacketed with steam at a pressure of several pounds above atmosphere. Use of steam trap prevents accumulation of condensate in steam jacket. Unit has maximum capacity for adding moisture to air at rate of 44 lb per hour. *Armstrong Machine Works, 812 Maple St, Three Rivers, Mich.*

Rotary Pump

ROTARY coolant and transfer pump differs from most vane pumps in not depending on either springs or centrifugal force to keep vanes in effective spanning position. This is accomplished by ring-assembly elements of hardened steel that engage underside of



tempered vanes and maintain latter in correct position to insure constant uniform flow of fluid. Rotor shaft is supported in self-oiling bearings and casing bore on which vanes slide is ground to fine surface. Units available up to 133 gph at 10-lb pressure. *Eddington Metal Specialty Co, Eddington, Pa.*

Arc Welder

WELD-O-TRON low-current electronic, in new size, is designed for a range of from 5 to 40 amps, and is especially built for

GARLOCK GIVES YOU ALL 3

1. Dependability
2. Long Life
3. Economy

THESE three qualities are essential for superior packing performance: 1. *Dependability* even under the most severe service conditions; 2. *Long Life* that prevents frequent shutdowns for repacking; 3. *Economy* that keeps down maintenance costs. Garlock gives you *all three*. For outstanding service, standardize on GARLOCK!

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PALMYRA, NEW YORK

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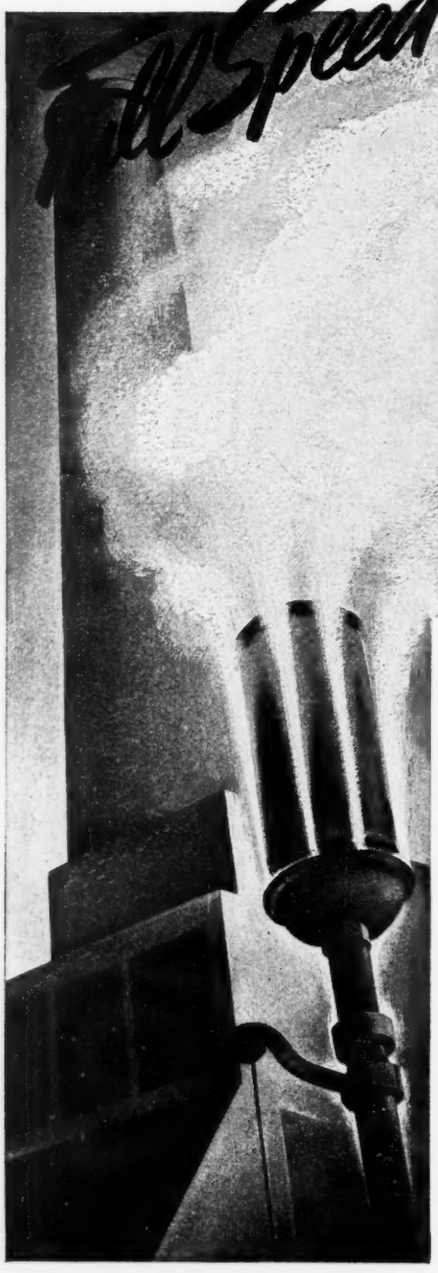
Garlock THE STANDARD PACKING OF THE WORLD



Full Speed Ahead!

DON'T LET DUST...

HOLD UP PRODUCTION

All the energy and effort, initiative and imagination that are the pride of American industry are needed for the work ahead in the year ahead. Whether your plant is producing directly or indirectly for defense, production must go "full speed ahead!"

Uncontrolled dust can bottleneck vital production in ways sometimes unsuspected—through reduced efficiency, excess rejects, lowered workers' morale. Are you sure that dust control may not be one of your problems? If you already have dust collection equipment . . . is it modern, *really* efficient?

You can find out by consulting the Buell Dust Technician in or near your city. The B.D.T. is an expert on dust in its relation to industry. On his recommendation many firms are now successfully using Buell Dust Collectors to help step up production and keep down costs. Only Buell Dust Collectors employ the highly efficient and economical van Tongeren System.

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Plymouth Motor Car Corporation
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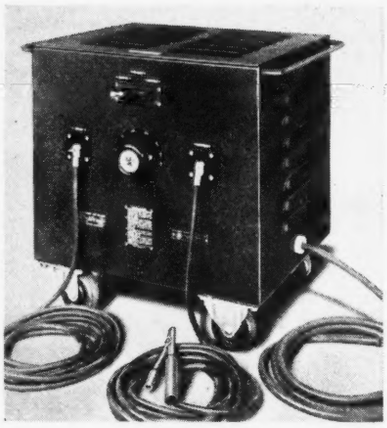
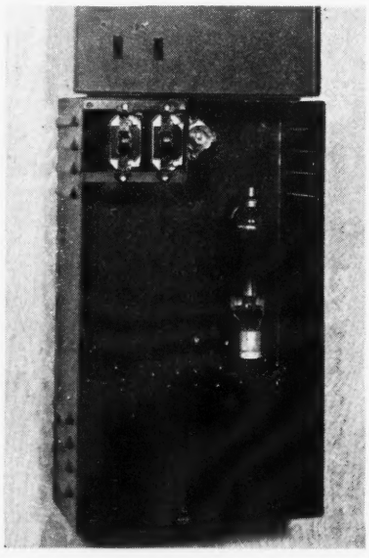


plants already equipped with motor-generator welders handling currents as low as 35 to 40 amp. Consists essentially of a 3-tube polyphase mercury-vapor rectifier circuit, eliminating all rotating parts. Accessible controls and terminals are on front panel. These are dead-front-type and consist of a 2-way switch for changing polarity of output terminals. Handwheel with easily-read dial provides fine adjustment. *Allis-Chalmers Mfg Co, Milwaukee, Wis.*

Electron-Tube Frequency Converter

THIRTY-CYCLE power supply is for converting power for operating industrial vibrating screens, conveyors, coolers, feeders, etc. This unit provides 30-cycle half-wave sup-

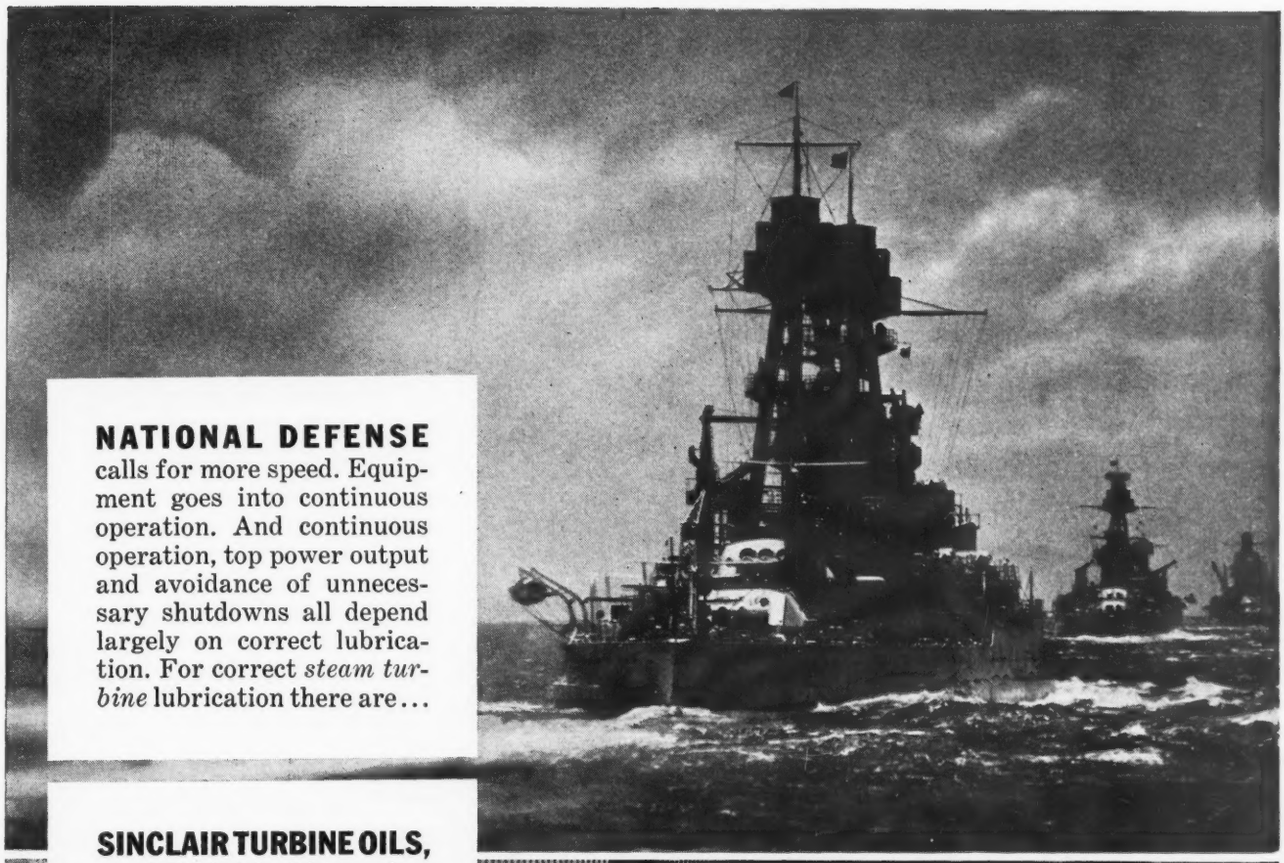


ply, with its 1800 vibrations per minute, from a 60-cycle line, and replaces a 15-cycle motor-generator set. Converter shown is 1500-watt size, uses 230-volt, 60-cycle input. Other sizes available from 9 kva up, for various frequencies, and voltages. *Clark Laboratories, Palm Springs, Calif.*

Plastic Packing

CRANE packing has new development in that it is now being made with patented tape back reinforcement vulcanized to out-

(*Continued on page 152*)



NATIONAL DEFENSE calls for more speed. Equipment goes into continuous operation. And continuous operation, top power output and avoidance of unnecessary shutdowns all depend largely on correct lubrication. For correct *steam turbine* lubrication there are...

SINCLAIR TURBINE OILS, specially finished for perfect demulsibility and high stability. They meet the demand of uninterrupted circulation. They resist the effects of high temperatures and moisture contamination. There is a Sinclair turbine oil suited to the individual conditions of your turbine. For details, or for advice on lubrication problems, write the nearest Sinclair office or Sinclair Refining Company, 630 Fifth Ave., New York.

* * *

(Right) **1500 k.w. GENERAL ELECTRIC** *steam turbine in Diboll, Texas, plant of Southern Pine Lumber Co. This turbine and other equipment in this plant Sinclair-lubricated.*

Write for "The Service Factor"—a free publication devoted to the solution of lubricating problems.

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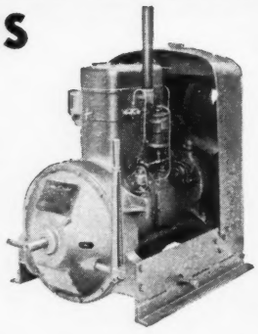
STOVER Two Cylinder Lanova DIESEL ENGINES *Are Now Ready . . .*



Smoother running. More power per cubic displacement and per pound, with proportionate lower cost. Available in 4 sizes and a variety of mounting bases. 7½ and 10 H.P. models are single cylinder. 15 and 20 H.P. are twin cylinder. Illustration shows conventional stationary type. Twin cylinder models have No. 1 Bell housing. Write Dept. D83A for Bulletin No. 51 with complete information.

STOVER MFG. & ENGINE CO., Freeport, Ill.

Model 125 Roto Tube Cleaner for 2½" curved tubes, equipped with 4-arm head.

No power plant can make money unless it is working—shutdown time costs money.

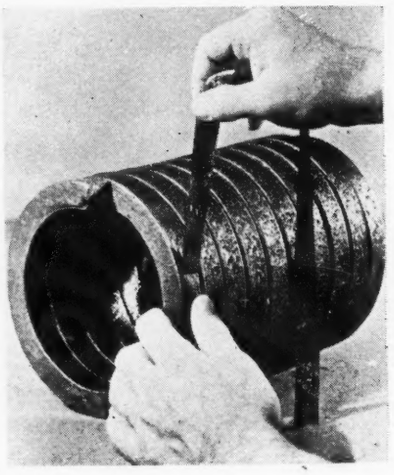
Features offered exclusively by Roto enable you to put your boilers back on the line 30% faster than with old type cleaners. New design Roto motor gives you greater power and more effective use of air consumed. The Roto rapid-action air valve on the motor permits one-man operation of cleaner. Rugged self-feeding cage and swing-frame heads, drills and universal joints keep replacement costs down to a minimum.

Let us send you full details.

See Our Adv. in Sweets and Write

The ROTO Company
145 Sussex Avenue, Newark, N. J.

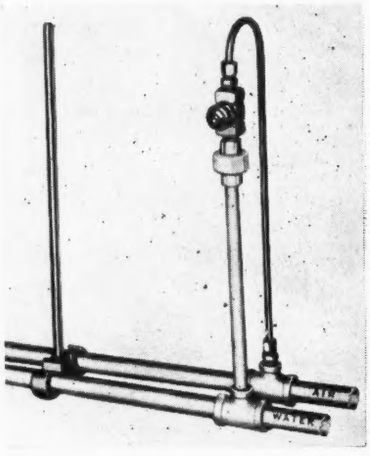
Roto Tube Cleaners are available for all sizes and shapes of tubes from ½" to 12" I. D., and for every kind of deposit.



er packing surface. This tape replaces old frictional woven cotton jacket and now non-frictional surface bears directly against moving part. Super-seal packing is dry-graphitized plastic packing made from long-fibre asbestos, anti-frictional metal particles and special binders. Packing is recommended for centrifugal and rotary services such as centrifugal pumps, rotary pumps, expansion joints, etc. *Crane Packing Co, 1800 Cuyler Ave, Chicago, Ill.*

Humidifying Nozzle

ILLUSTRATION shows a humidifying nozzle, which is placed with others in ceiling where water is maintained slightly below nozzle level by means of float-controlled tank.



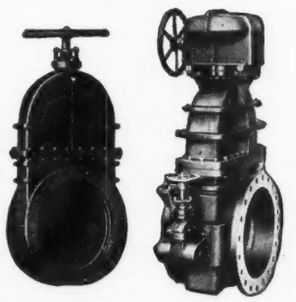
Compressed air is controlled by solenoid-operated valve actuated by a humidistat. If for any reason air is shut off, water will drop back to controlled level. *Spraying Systems Co, 4021 W Lake St, Chicago, Ill.*

Oil Burner

MODEL LF burner is air-atomizing type, suitable for ovens, dryers, ignition torches in boilers, and other heater applications. Standard commercial grade oils Nos. 1, 2, 3, 4, and light grades of No. 5 can be used without making any adjustments. Instead of high-pressure pumps, atomization is secured by small jet of compressed air. Compressors are small, and inexpensive to operate because of low pressure

When you need Iron-Body Double-Disc Gate Valves

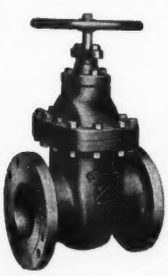
Some of the Kennedy Iron-Body Double-Disc Gate Valve Types



Low-pressure non-rising stem flanged valve

Electrically operated valve with by-pass and square bottom

125-lb. outside-screw-and-yoke screwed valve



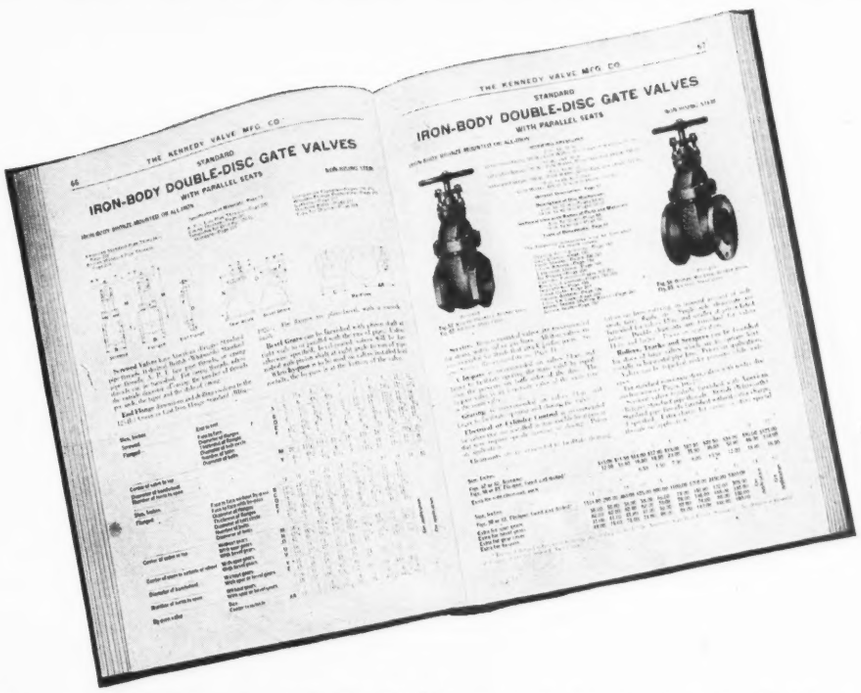
250-lb. non-rising stem flanged valve

Bell-end valve for water mains

800-lb. valve for oil or gas

Small electrically operated valve

Cylinder operated valve



You will find 568 different types and sizes in the new Kennedy Catalog

Whether you require valves for low, standard, or extra heavy pressure, for steam, water, oil, air or gas, and for operation by hand, gear, cylinder or electric motor, you will find an exactly suitable type in the Kennedy catalog—with all data complete and conveniently arranged.

Some of the distinctive features of this new catalog are dimensions, prices and service recommendations on the same or facing pages for all types of valves, large illustrations throughout, sectional views with part lists for all valves, convenient references to accessories and pipe end standards, five different indexes for greatest ease of finding the desired information, and a large section of useful engineering data. Every operating and designing engineer should have a copy of this informative 240-page letter-size cloth-bound volume.

The Kennedy Valve Mfg. Co. . . Elmira, N. Y.

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KENNEDY

Extra Values in VALVES and PIPE FITTINGS

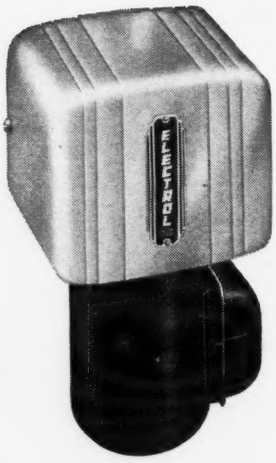
They're as Different as Your HUMIDITY CONTROL PROBLEMS

★ Johnson room type "humidostats," as illustrated (and also those of the insertion pattern to sense humidity in ducts), are provided with any one of a number of different types of elements, to fit each particular application.

"LOOK AT THE WHOLE SYSTEM"

That is the *Johnson* thought behind the selection of exactly the proper type of "humidostat" for each individual humidity control installation. In solving automatic temperature and air conditioning control problems, always in the minds of *Johnson* engineers is the indisputable fact that even the most efficient devices are valuable only when they function perfectly as part of the whole . . . Almost every installation differs as to the relative humidity to be maintained and the dry-bulb temperature with which that humidity is associated. Various materials, which respond dependably to changes in the moisture content of the surrounding air, are affected differently under each set of conditions. That is why *Johnson* offers "humidostats" with any one of several types of elements, such as animal membrane, human hair, wood in various forms, and other substances . . . Ask for bulletins describing *Johnson* room and insertion type "humidostats." There is no obligation. A post card will bring them.

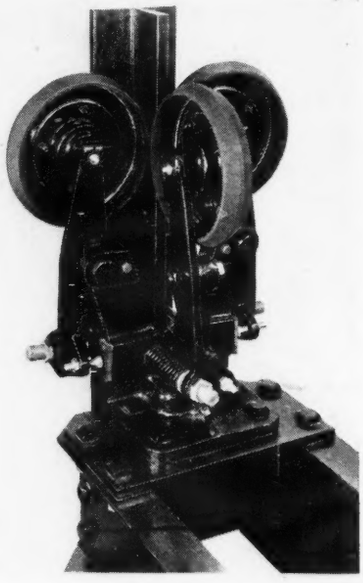
JOHNSON
AUTOMATIC TEMPERATURE AND AIR CONDITIONING CONTROL
JOHNSON SERVICE COMPANY, MILWAUKEE, WIS. AND PRINCIPAL CITIES



needed. For installation, a few bricks are placed in combustion space and burner is bolted to front of combustion chamber. Electric wiring and oil piping can be installed in a short time. *Electrol Inc, 934 Main Ave, Clifton, N. J.*

Elevator Roller Guides

WITH OTIS ROLLER GUIDES, both elevator car and its counterweight are guided by large, spring-cushioned, rubber-tired wheels, instead of sliding shoes. These roller guides operate on dry rails. As a result,



hoistways may be free of all oil and grease, and cleaning hoistways become a matter of removing dust, not oil-soaked dirt. Elimination of oil reduces fire hazard and reduction of friction reduces power consumption. *Otis Elevator Co, 260 11th Ave, New York, N. Y.*

Motor Starters

COLT magnetic motor starters are constructed for across-the-line starting of single and polyphase squirrel-cage induction motors, and as primary control for wound-rotor induction motors. Important feature is 3-point ball-bearing suspension of movable electro-magnet, assuring a float-

Before you order "SPECIAL" Automatic Valves

CHECK with DAVIS!

RIGHT now many engineers are faced with a problem. To get the kind of performance they want involves SPECIAL design and construction in the equipment going into power, process and heating jobs; but to get quick delivery and reasonable costs, wisdom dictates use of STANDARD items wherever possible.

It is in such situations that DAVIS can immediately come to your assistance with what is believed to be the broadest line of automatic valve specialties in existence today. Features which you might consider "special" are often found to be standard with DAVIS, making unnecessary a long wait for special equipment to be designed and built. *For your own protection, always make it a habit to check with Davis on any automatic valve need!*

Do you have the latest DAVIS Bulletins Handy?

DAVIS REGULATOR CO.
2540 S. Washtenaw Ave., Chicago

Without obligating me, please MAIL literature describing:

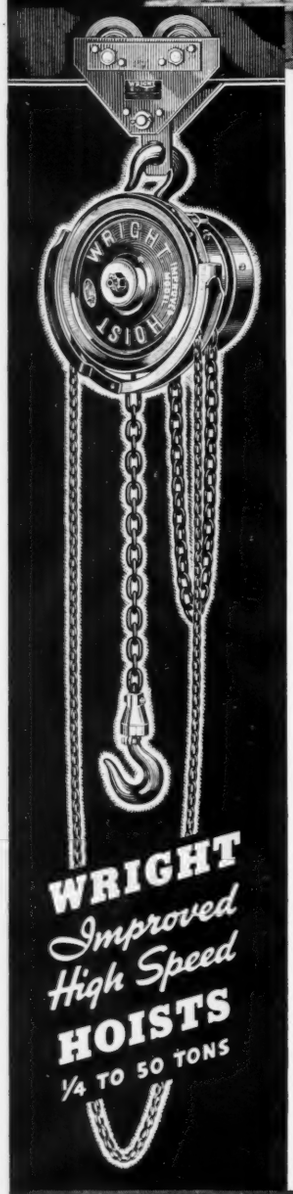
- ☐ Pressure Regulators and Pump Governors (including service and capacity charts).
- ☐ Pressure Relief, Back Pressure, and Exhaust Relief Valves.
- ☐ Liquid Level Controllers for closed tanks.
- ☐ Lever and Float Operated Valves.
- ☐ Solenoid Valves for Industrial service.
- ☐ Stop and Check, Non-Return and Balanced Check Valves.
- ☐ Strainers.
- ☐ A specific problem is outlined on the attached sheet. We would appreciate your recommendations.

Name .....

Company .....

Street .....

Town ..... State .....



WRIGHT
Improved
High Speed
HOISTS
¼ TO 50 TONS

● ***Speed — economy — safety!*** That's the demand of American industry today. And the **Wright Improved High-Speed Hoist** is one of the answers to that demand.

In the first place, the inclusion of the words "High Speed" in the WRIGHT HOIST name is a statement of fact. They mean what they say. The WRIGHT HOIST *is fast,* smooth and positive in action—because of its load wheel and driving spindle bearings.

Wright's economy comes through its rugged and precision design—its year-in and year-out durability—its full zinc coating which makes WRIGHT HOISTS immune to corrosion.

And safety is inbuilt. The load chain has a safety factor of 7 to 1 and the special process steel of which it is made permits the chain to elongate (because of overload) 3″ to the foot before breaking. This same visual factor of safety is inherent in the bottom hook because this hook will slowly open to indicate overload beyond the elastic limit of the chain.

WRIGHT TROLLEYS are made to give the same fast—economical—safe service as WRIGHT HOISTS. Write for your copy of the new Wright Catalog and learn the 21 points of WRIGHT superiority.

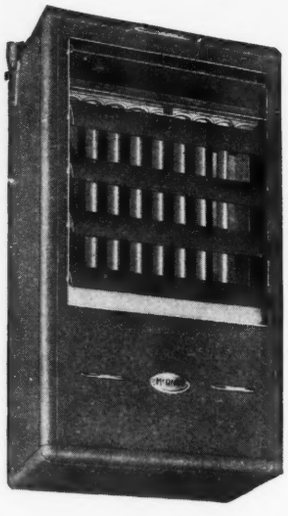
WRIGHT MANUFACTURING DIVISION
YORK, PENNSYLVANIA

ACCO

AMERICAN CHAIN & CABLE COMPANY, Inc.
In Business for Your Safety

ing action that minimizes friction and guides contacts smoothly into correct alignment. Magnet operates vertically

and cannot close accidentally by vibration or shock. Can be furnished for remote control, local control or with transfer switch in cover. *Colt's Patent Fire Arms Mfg Co, Electrical Div, Hartford, Conn.*



Unit Heater

GAS-FIRED UNIT HEATER has adjustable louvres, control system, and thermostatic control with sequence starting and complete safety control. Room thermostat closes fan motor and transformer circuits simultaneously, transformer energizes solenoid gas valve, opening it. Solenoid gas valve can remain open only if pilot is ignited and fan operating. *McQuay, Inc., 1628 Broadway, N.E., Minneapolis, Minn.*

Engineers' Books

(*Continued from page 122*)

for figuring friction of petroleum products in pipelines, specific pump curves, pressure-temperature curves and chart showing resistance of valves and fittings to flow of fluids. Recommendations of materials to be used in pumps handling various liquids, instructions for installing and

THESE FLOORS DOUBLE AS WINDOWS

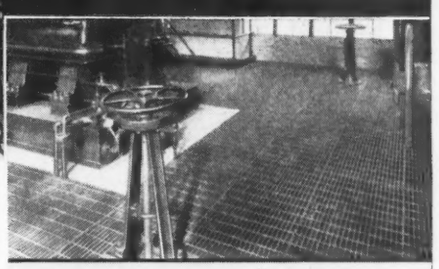
FACTS ABOUT OPEN STEEL GRATING

ONE of the primary functions of Open Steel Grating floors and steps is to admit air and light to the areas above or below their surface. No other flooring material performs both these functions in a manner as efficient. Not only does this strong, rigid flooring provide free circulation of air and escape of fumes, gases and heat, but it also admits light.

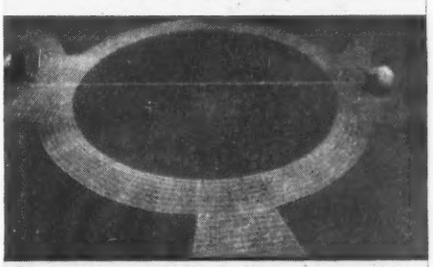
Open Steel Grating is permanent and durable. Because of its open construction, it does not accumulate dust, dirt, grease, oil or moisture. When used for outside walks it will not collect ice, snow or water. It is factory fabricated from a combination of structural members rigidly connected by riveting, welding or interlocking.

Open Steel Gratings are built to the requirements of the individual job, insuring fast and economical installation and a perfect fit. For more detailed information on this strong, non-slip, rigid flooring that admits the passage of air and light, write today for the free booklet shown below.

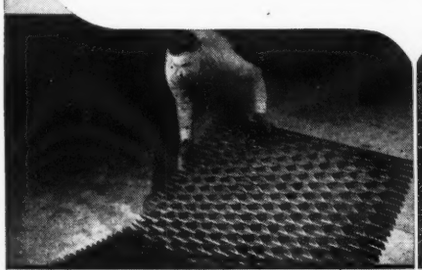
OPEN STEEL FLOORING INSTITUTE, INC.



SELF-CLEANING. Open Steel Gratings do not accumulate dust, dirt, grease, oil or moisture. Their construction makes them virtually self-cleaning.



ECONOMICALLY INSTALLED. Every section of Open Steel Grating is built to the requirements of the individual job. This factory layout insures speedy installation and perfect fit.



LIGHT WEIGHT. Every pound of material is used, with maximum efficiency to carry or distribute loads — meaning less dead weight, lighter supports, reduced erection costs.

NON-SLIP SAFETY. Open Steel Gratings cannot accumulate skid-inducing substances — provide an even, non-slipping, stumble-proof surface.

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Send me, without obligation, your new booklet, "New Ideas in Functional Floor Design."

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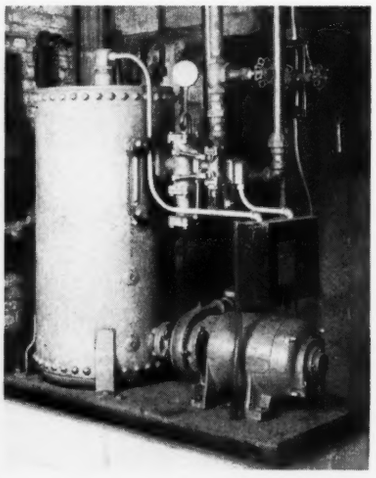
PRESSURE EQUALIZING PUMP
wins Industry's endorsement

These users are typical of the long list of well-known firms who have "Pressure Equalizing" Savings.

Du Pont Company, El Monte, Calif.
Holly Sugar Co., Torrington, Wyo.
Van Camp Milk Co., Angola, Ind.
Dry Zero Corp., Buchanan, Mich.
Champion Paper & Fibre Co., Sandersville, Georgia
Cannon Mills, Social Circle, Ga.
U. S. Naval Air Station, Pensacola, Florida
Hotel Roosevelt, New Orleans, La.
Coca Cola Bottling Co., Canton, Ohio
Hiteman Leather Co., W. Winfield, N.J.
Union Laundry, Newark, N. J.



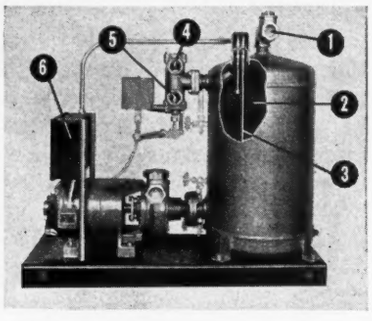
● Johnson No. 250 SH Pressure Equalizing Boiler Feed Pump installed in the plant of the Blocksom Co., Michigan City, Ind. This unit is fully A.S.M.E.-approved, designed for boilers up to 250 Hp., 150 lbs. pressure. Smaller sizes down to 30 Hp. capacity are available.

SOME things are almost too good to be true. If you have felt that way about the big savings claimed for the Johnson "Pressure Equalizing" Boiler Feed Pump, this endorsement by so many of Industry's "Who's Who" will reassure you.

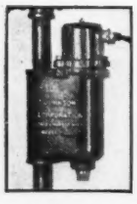
These firms, and hundreds of others like them, accepted the Johnson Pump only after searching analysis had convinced them that the "Pressure Equalizing" method of boiler feeding could:

1. Cut power pumping cost as much as 60%.
2. Increase thermal efficiency — save fuel — 10 to 15%.
3. Cut pump maintenance cost to the bone.

Write for new bulletin which will show you clearly how this revolutionary boiler feed pump and the Johnson High Temperature Condensate Return System can obtain savings like these for your plant.



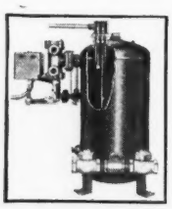
HOW IT WORKS—Condensate enters inlet (1) filling equalizing chamber (2) until water across electrodes (3) completes circuit to relay (6). This operates two way valve, admitting steam from boiler through inlet (4) thus equalizing chamber with boiler. Pump is started simultaneously—*its only task to raise water a few feet to boiler level, not overcome boiler pressure.* When contents are pumped into boiler, inlet (4) is closed, pump is stopped and steam is exhausted to a condensing receiver through port (5). Cycle then repeats.



Other Johnson Developments

BOILER WATER LEVEL CONTROL. Dependable, low cost, easily installed automatic boiler level control utilizing new electrical operation—a perfect team-mate for the Johnson "Pressure Equalizing" Boiler Feed Pump.

JOHNSON ELECTRAP. Today's highest development in a boiler return, pumping or lifting trap utilizing new dependable electrical operation. Control valve assembly can be placed in any convenient location if trap chamber has to be mounted in some inaccessible spot.



Product of The Johnson Corporation
885 WOOD STREET, THREE RIVERS, MICHIGAN

158 (69e)

operating different kinds of pumps, and other material has been revised and brought up to date.

THE MARKET FOR ENGINEERING SERVICES—1940-1950. *Published by American Association of Engineers, 8 South Michigan Ave, Chicago, Ill. 64 pages, price $.50.*—Develops thesis that there is close fundamental relation between adequate Civil Service and Professional Licensure. Developed and based on statistical analysis of experience records of almost 600 engineers, and similar analysis of specifications set up by employers of engineers. Other predictions depend on analysis of actual placements of engineers over a 12-year period, with special emphasis on age restrictions, salary trends, hourly wage scale, new technologies, etc.

ANNUAL REPORT—PASADENA MUNICIPAL LIGHT & POWER DEPARTMENT (1939-40). *City of Pasadena, California, thirty-third annual report.*—Gross revenues, kilowatt hours sold, etc, included in annual report. Graph entitled "How Your Dollar Has Been Distributed" shows percentages for various expenditures. Curves showing peak loads, typical daily loads, etc, included.

MODERN TRENDS IN NICKEL STEEL AND CAST-IRON GEAR MATERIALS. *By C M Schwitter, International Nickel Co, New York, N. Y. Published by the International Nickel Co, 67 Wall St, New York, N. Y. 16 pages, paper bound.*—Presents factors which have contributed to gear progress, and shows how nickel steels and cast iron have been used more and more as improvements in gearing took place.

LEFAX DATA. *Lefax, Inc, Philadelphia, Pa.*—Latest Lefax bulletins of interest to POWER readers include the following: No. 40-17, "Fluorescent Lamps"; No. 18-33, "Concrete Floors"; No. 7-265, "Steam Meters"; No. 35-11, "Coals of the United States—Analyses and Heat Values"; No. 19-12, "Roller Bearings"; and No. 10-226, "Valve Timing".

Reader's Problems

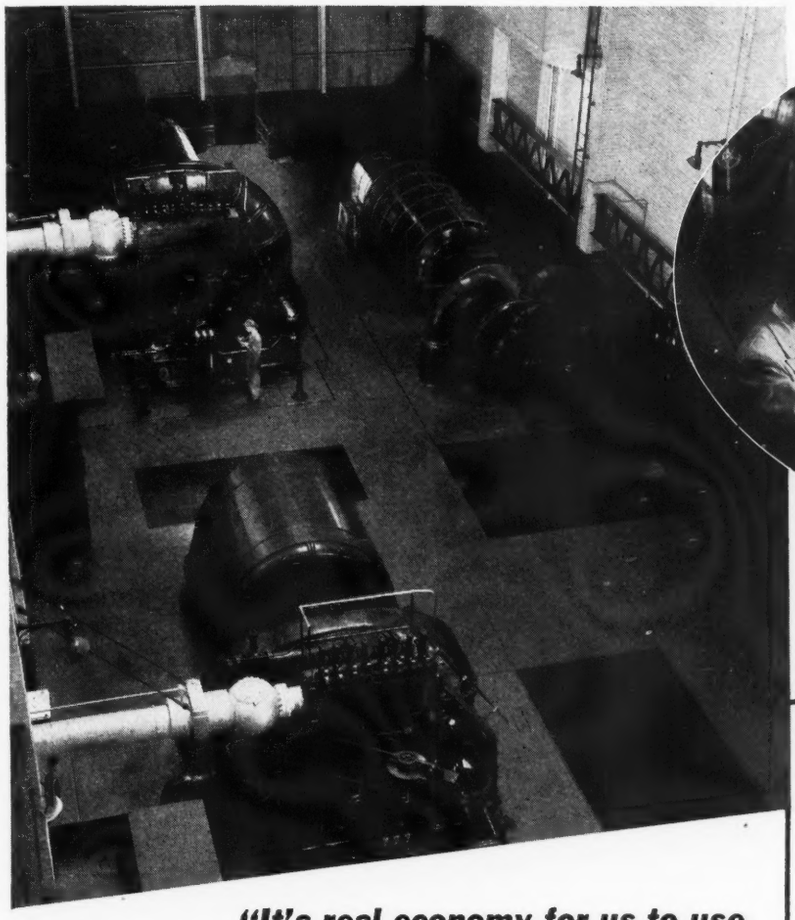
(*Continued from page 113*)

of the wedge, which, although not always enough to develop an appreciable "knock" in the brasses, is still sufficient to cause fatigue failure of the wedge bolts. This is particularly true where two bolts are used and where the adjustment of the brasses depends entirely on the wedge, with no shims between brasses.

I have eliminated wedge-bolt breakage entirely on a 2000-cfm compressor connecting rod by using a single bolt made of ordinary cold-rolled steel, screwed through the wedge block and locked with two nuts. Although brasses have needed taking up at intervals, we have not had a wedge bolt break in 18 months. Shims between the brasses will also eliminate breakage as the brasses and wedge block are always

"Gulfcrest Oil has made a great SERVICE RECORD in our Turbines"

...Says this Power Plant Supt.



Looking over the records with the Gulf Engineer, this Power Plant Superintendent says, "We've saved both time and money with Gulfcrest in our turbines."

"It's real economy for us to use GULFCREST... it resists deterioration and relieves us of oil worries."

"GULFCREST Oil has out-performed all the other turbine oils we've ever used," says this Power Plant Superintendent. "This Alchlor-processed turbine oil, with its high resistance to deteriorating influences, has given us complete freedom from lubrication difficulties."

Read the *four reasons* (at the right) why Gulfcrest is the finest turbine oil you can buy. Ask a Gulf Engineer to give you the entire story about Gulfcrest Oil, and what it can do for you. Let him tell you how GULF PERIODIC CONSULTATION SERVICE can help you maintain greater lubrication efficiency—there's no obligation. Write or phone your nearest Gulf office today!

4 Reasons....

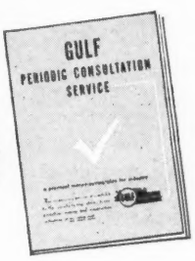
1. *Refined by the* ALCHLOR *Process.* The most thorough and effective method for removing chemically active hydrocarbons as well as the general run of impurities present in all crudes.

2. *Highest resistance to oxidation.* This famous ALCHLOR Process synthesizes and rearranges the molecular structure of certain hydrocarbons, resulting in a finished product of greater stability. GULFCREST OIL stands alone in its high resistance to oxidation.

3. *Highest resistance to acidity and sludge.* Because of the elimination of oxidation catalysts in addition to the unparalleled refining power of the Alchlor Process, these oils form less gum deposits, less emulsion and sludge, when mixed with water over a period of several years' continuous operation, than any other turbine oil of which we have record.

4. *Highest kilowatt-hour performance.* Because Alchlor not only makes possible an oil more thoroughly refined and homogeneous but also creates anti-oxidants, these oils have great resistance to deteriorating influences and are longer lived. Less make-up oil is required.

GULF INDUSTRIAL LUBRICATION



Gulf Oil Corporation - Gulf Refining Company P.
3800 Gulf Building, Pittsburgh, Pa.

Please send me my copy — no charge — of the booklet "GULF PERIODIC CONSULTATION SERVICE."

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Company .....

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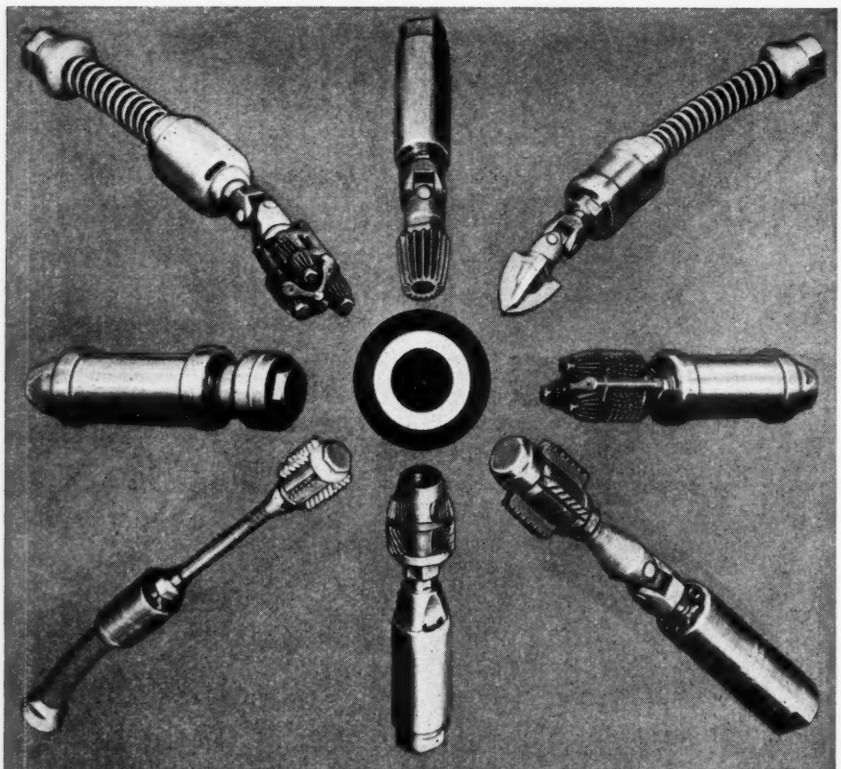

FOR *BETTER* TUBE CLEANING
SPECIFY A WILSON CLEANER

Wilson tube cleaners do *a better, faster, more economical* tube cleaning job because they are designed and built for the specific work they have to do. There's a Wilson motor, cutter head, brush or other accessory especially suitable for efficiently, economically and safely removing hard or soft scale from *any* straight or curved pipe—of ferrous or non-ferrous metal—of large or small diameter—that can be cleaned mechanically.

Wilson tube cleaning equipment is used exclusively in thousands of power plants throughout the world—proof of its superior quality. Write for the name of our representative nearest to you or send for a copy of our new thirty-six page catalog fully describing and illustrating the complete line of Wilson tube cleaning equipment.

THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
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SAVE AIR—SAVE DOLLARS
WITH
ROCKWELL BLAST GATES
For Low Pressure Air
Slide Type Butterfly Type
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Kwikleen Type

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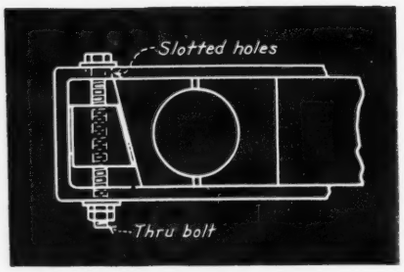
Write for catalog No. 3760
W. S. ROCKWELL COMPANY
50 CHURCH ST., NEW YORK

Wafer Butterfly Flanged Type



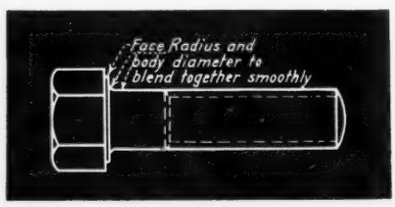
held tightly in place, no matter how loose the crankpin may be. This method has its faults, as close adjustment of the brasses is inconvenient, but is satisfactory where brasses will run over a long period without having to be taken up.

McKenzie Island, Ontario S J BURTON

Bolt Design Must Be Right

WEDGE-BOLT BREAKAGE may be traced to one or more of the following (1) workmanship, (2) material, and (3) design. When making a replacement bolt a fillet should be provided under the head of the bolt, as shown in the sketch. The machinist should take great pains to blend the surface of the fillet smoothly into the faced-under portion of the head and also into the body diameter of the bolt. A sharp corner at this point tends to concentrate stresses, making a likely failure point.

In installing the bolt, the mechanic should see that the wedge has a good bearing surface on its seat in the connecting rod, that the bolt does not bind on the side of the hole when screwed into the wedge, and that the fillet does not bear on the side of the hole. The bearing the bolt makes on the clamping surface of the connecting rod should also be checked

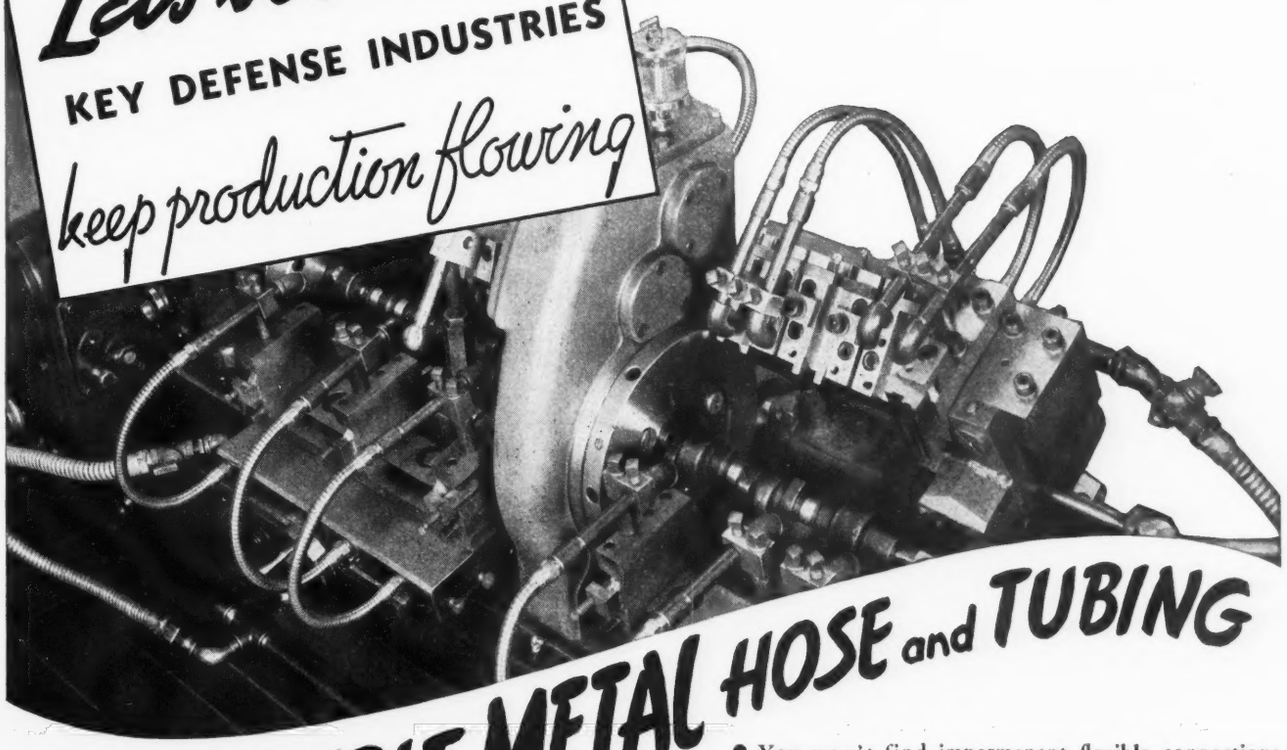


and should show a bearing all the way around the head. Any stresses set up by the bolt bearing on the side of the hole or on one side of the head will become excessive when the engine is in operation and soon causes the bolt to fail.

Material used must be strong but must not have any marked tendency to fail under repeated stress. Do not use tool steel. A 0.40 carbon steel is good. Better, use an SAE 3140 steel, heat treated as follows, after machining: heat to 1500 F, quench in oil, and draw at 850 to 950 F, which will give a Brinell of about 265. Poor design may often be overcome by use of better steel and attention to details such as smooth fillets and surfaces, better bearing surfaces and fillets of larger radius.

Seaford, Del. G V DOEHNE

Let's see how KEY DEFENSE INDUSTRIES keep production flowing

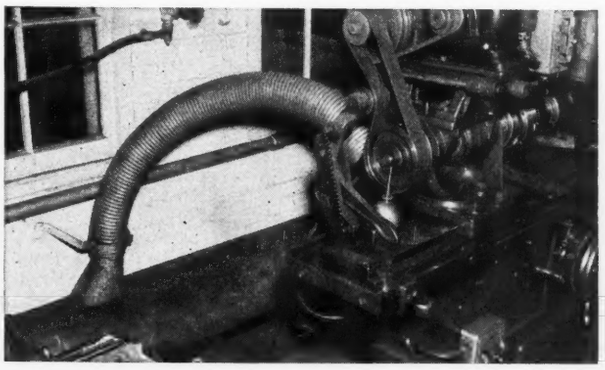


with FLEXIBLE METAL HOSE and TUBING

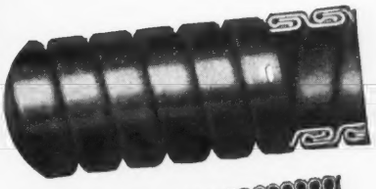
● You won't find impermanent flexible connections on modern equipment that is now swinging into action for defense. Shut-downs for repair or replacement of oil, air or coolant feed lines can be so easily eliminated.

Note the many Flexible METAL Tubing sections that serve as coolant "arteries" on the modern machine tool illustrated above . . . they're easily adjustable, clean, normally good for the life of the equipment.

Perhaps there is a place in your plant, or on the equipment you make, where just such good qualities will help keep production flowing? Many types, many sizes, many metals are available for a practically unlimited range of uses. Send for your copy of our "Fact Book".

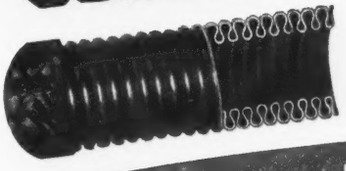


GRINDER EXHAUST . . . There's plenty of vibration, and lots of abrasive action in the grinding wheel chips that whizz through this Flexible METAL Exhaust Hose, but it's easily going to outlast previously used materials.



●

A typical section of helically wound, interlocked, Flexible METAL Hose, showing the design of the joint and the position of the lubricated asbestos packing.



●

A typical section of convoluted Flexible METAL Tubing showing the protective braided metal covering.

Flexible METAL HOSE AND TUBING INSTITUTE

FLEXIBLE Metal HOSE and TUBING INSTITUTE

150 BROADWAY NEW YORK, N.Y.

Please send me, without obligation copy of your "FACT BOOK".

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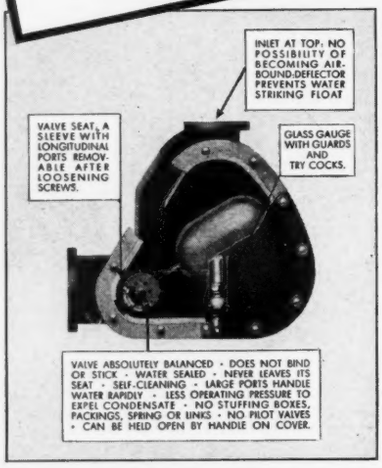
★ P-A

How **COCHRANE MULTIPORT DRAINER permits *Quick* drainage of *Large Quantities* of condensate**


INLET AT TOP; NO POSSIBILITY OF BECOMING AIR-BOUND-DEFLECTOR PREVENTS WATER STRIKING FLOAT
VALVE SEAT, A SLEEVE WITH LONGITUDINAL PORTS REMOVABLE AFTER LOOSENING SCREWS.
GLASS GAUGE WITH GUARDS AND TRY COCKS.
VALVE ABSOLUTELY BALANCED · DOES NOT BIND OR STICK · WATER SEALED · NEVER LEAVES ITS SEAT · SELF-CLEANING · LARGE PORTS HANDLE WATER RAPIDLY · LESS OPERATING PRESSURE TO EXPEL CONDENSATE · NO STUFFING BOXES, PACKINGS, SPRING OR LINKS · NO PILOT VALVES · CAN BE HELD OPEN BY HANDLE ON COVER.

THE "Multiport" principle on which Cochrane Drainers operate is that of a hollow cylindrical valve with a number of longitudinal ports which register with similar ports in the valve seat when the float is in the raised position. The combined capacity of these ports is unusually large which accounts for the valve's extraordinary discharge capacity. Mail this coupon today—

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Cochrane Corp., 3106 N. 17th St., Phila., Pa.
Please send me a copy of your Publication 2850 on Multiport Drainers.

Name.....
Firm.....
Address.....
City.....State.....

Power Lines

(*Continued from page 134*)

name. When Mr Clans retired 10 years ago, his son, Harry E, was appointed to and still holds the position of chief engineer.

CHARLES A BARTLETT, 76, who retired in 1938 as treasurer of the Graton & Knight Co, Worcester, Mass., after 46 years of service with that company, died in the Holden District Hospital, near Worcester, Mass., on Nov 10. He was a native of Rutland, Mass., and was graduated from the Worcester Polytechnic Institute.

JAMES J STAFFORD, 48, a native of Booth, Ohio, and manager of the Otis Elevator Co's construction activities in Connecticut and Western Massachusetts, died at the Hartford Hospital November 15, after a short illness.

HOLLIS FRENCH, 72, widely known consulting engineer at Boston, Mass., and a former partner in the firm of Hollis French and Allen Hubbard, died at his home in that city on Nov 21. He was graduated from the Mass. Institute of Technology in electrical engineering in 1889. In practice he was active in design and construction of power plants and institutional buildings, some of his latest work being for Yale University in New Haven, Conn.

FRANK A VAUGHAN, 65, former chief engineer of the American Woolen Co, and retired executive of the American Optical Co, died at his home in Southbridge, Mass., on Nov 20. He was a graduate of Harvard and specialized in engineering at the former Lawrence Scientific School at the university.

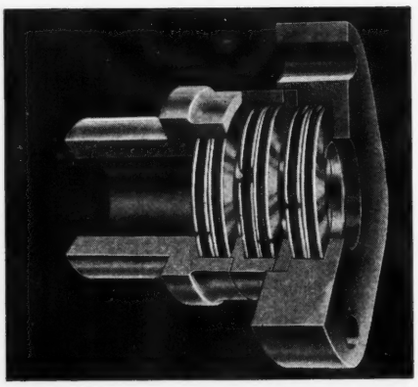
ROBERT F CLARK, 62, superintendent of the municipal light and water plant at Starke, Fla., died recently at the home of his brother in Charleston, Miss. He had been superintendent of the plant since 1923.

CAPT W P LAY, founder of the Alabama Power Co, and leader in the industrial development of Gadsden, Ala., for more than half a century, died suddenly at his home there. He built the first electric light plant in Gadsden and was active in the establishment of Gadsden's first blast furnace. Lay Dam, a project on the Coosa River, was named in his honor.

WILLIAM E BAKER, 53, executive vice-president of the Arkansas Power & Light Co, died at his home in Pine Bluff, Ark., recently, following a heart attack. He joined the company at Arkadelphia in 1915 and came to Pine Bluff in 1917.

PERSONALS

HARRY T HALLSTEIN has been appointed application engineer for Air Conditioning Equipt of McQuay, Inc, Minneapolis, Minn. He received his mechanical engineering degree from Purdue University in



France Metal Packing, Type No. 210, has three pairs of wearing rings and is suitable for pressures up to 150 lbs. Chiefly used on small rods and valve stems. It is outstanding for its economical and efficient performance on Corliss valve stems.

Speed

PRODUCTION *with* FRANCE METAL PACKING

Speed up the preparedness program. Install FRANCE Metal Packing and obtain maximum engine, pump and compressor service.

. . . Eliminate packing failures. The "full-floating" principle of France sectional metal rings in a metal case provides top efficiency under all conditions of temperature, pressure and speed.

. . . Prevent crankcase oil from escaping and condensation from entering the crankcase in numerous applications.

. . . Wide adaptability and downright economy. Installed in many of the largest plants in all parts of the world on steam, air and all types of gas units. A France Metal Packing installation means fewer shutdowns and less maintenance.

. . . Accurate records maintained for quick renewals or replacements.

. . . Nearly half a century of specialized experience.

. . . Prompt engineering service through experienced local representatives.

Help yourself to economy and faster production with FRANCE Metal Packing.

Write for Catalog M-7.

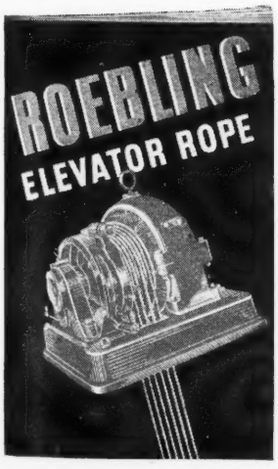
THE FRANCE PACKING COMPANY

Tacony, Philadelphia, Penna.
Branch Offices in Principal Cities

Original **FRANCE METAL PACKING**

DO YOU BUY ROPE

on this basis?



Ask for your free copy of the Roebling Elevator Rope Bulletin containing valuable information on installation, lubrication and care of Roebling Elevator Ropes, etc.

In elevator rope, your problem resolves itself to a question of how soon broken wires will appear... how long before the rope must be replaced... how many miles of service can you expect per rope dollar.

Here's one way to get the answer:—Keep accurate records of each rope from installation to replacement. And remember, it's the *average* service of *all* your ropes that is the true measure of rope economy.

We recommend this test to you because we know the worth of Roebling "Traction Steel" Elevator Rope. We developed it specially—through years of research. We make every ladle of steel that goes into it... and control fabrication every step of the way.

These are the reasons why Roebling Rope gives you lowest service cost—with safety.

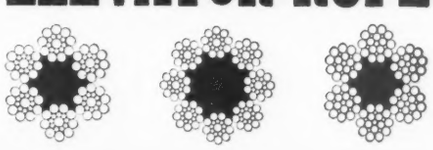
Also ask about Roebling Electrical wires and cables for elevator use—made to high standards of quality which assure safe, dependable service.

JOHN A. ROEBLING'S SONS CO.
Trenton, N.J. Branches in Principal Cities

ROEBLING

"Traction Steel"

ELEVATOR ROPE



ROEBLING "TRACTION STEEL"... for Maximum Rope Safety and Economy!

Date PACKING RECORD
Jan 4 repacked stuffing box pump No. 3
Jan 8 adjusted stuffing box pump No. 1
Jan 15 shut down pump No. 3 Hot stuffing box
Jan 21 repacked stuffing box pump No. 2
Jan 30 replaced scored shaft sleeve pump No. 1

If your pump maintenance record has items like these··· Switch to

PALMETTO
for steam and hot fluids

PALCO
for water

PELRO
for solvents, oils

CUTNO
for alkalis

SUPER CUTNO
for acids

What is the evidence that Greene, Tweed Packings put an end to such annoyances and expenses? Here it is, and it's mighty convincing proof: *More than 90% of the engineers who have tried out working samples of these packings have become permanent users.*

These engineers have demonstrated to their own satisfaction that our packings actually do last longer and give better service. Start the New Year right by making the test for yourself.

Greene, Tweed & Co.

101 Park Ave. . . . New York

* Reg U. S. Pat. Off.

FREE WORKING SAMPLE

Here's our offer. Test any Greene, Tweed packing or the new Palmetto SuperSheat under your own operating conditions. No charge, no obligation. Just fill in and mail the coupon, and your free sample will be sent by return mail.

Greene, Tweed & Co., 101 Park Ave, New York

Send free working sample of packing.....size,

for ..... service.

Send free working sample of Palmetto SuperSheat.

Name .....

Company .....

Address .....

1932. He comes to the present company after doing research at the university for his Master's Degree, and will devote his time to field and factory research and development work.

EARL G MORGAN, who has been active in air conditioning and refrigeration since 1914, has recently joined the Air Conditioning and Refrigeration Div, Worthington Pump & Machinery Corp. His headquarters are at the corporation's Kansas City, Mo., office. Mr Morgan formerly served as sales manager of the Refrigeration Dept of the United Iron Works Co; was associated with the Frick Co, and served as representative of the Vilter Mfg Co, Kansas City.

L G ATKINSON has been appointed manager of a new section of the Circuit Breaker Sales Dept, Westinghouse Electric & Mfg Co. Mr Atkinson was graduated from the electrical engineering school of North Carolina State College in 1933. After two years in the Westinghouse student course, he entered the engineering dept of the Switchgear Div. In 1936 he went to the sales dept of that department, and now has been made head of sales for small circuit breakers.

ROBERT N MIERS, for the past six years a traveling representative of the Allis-Chalmers Mfg Co, on steam-turbine sales and general engineering matters, has been appointed eastern district manager with headquarters at the Boston office of the company.

ALBERT B MILLEY, head fireman at the power plant of the River Works of the General Electric Co, Lynn, Mass., retired recently after 36½ years of service.

W C BUCHANAN, president of Globe Steel Tubes Co, Milwaukee, was elected a member of the board of directors of Allis-Chalmers Mfg Co recently. He was named to fill one of two vacancies on the board created by the deaths of Otto H Falk, former board chairman, and Oscar Gubelman, director for many years.

MASON BRITTON, vice chairman of McGraw-Hill Publishing Co, has been advanced to the post of director of Machine Tools and Heavy Ordnance Division of the National Defense Advisory Commission. Mr Britton succeeds Harold S Vance, chairman of Studebaker Corp, who has had to relinquish his full-time duties but will continue with the division as a consultant.

L R LUDWIG has been appointed manager of newly combined sections of Westinghouse Electric & Mfg Co. Switchgear Div. He has been manager of protective devices engineering for the past five years, and will now head the combined division of Circuit Breaker and Protective Devices Engineering.

DAVID C MILLER, Hall Laboratories Engineer, has been appointed to the service staff of Eshelman and Potter, of Charlotte, N. C. He will represent Eshelman and Potter interests in water-conditioning service among southeastern industrial plants.

The time to Stop Trouble is before it starts - - - -

It's always hazardous for nuts to work loose. The effect may mean injury to some workman or damage to your equipment. Play safe. Use

UNSHAKO
Reg. U. S. Pat. Office

The Nuts that can't shake loose

on foundations and all moving parts of Diesels, Reciprocating Engines, Pumps, Conveyors, Generators, Stokers, etc. They "spring to life" and grip the bolt or stud whenever there's a backing-off tendency and thereby insure permanent tightness. Of course, they can be removed with a wrench and used over again if desired. Write for complete details.

Pat'd & Pat's. Pending

STANDARD PRESSED STEEL CO.
JENKINTOWN, PENNA.
Boston Detroit Indianapolis Box 577 Chicago St. Louis San Francisco

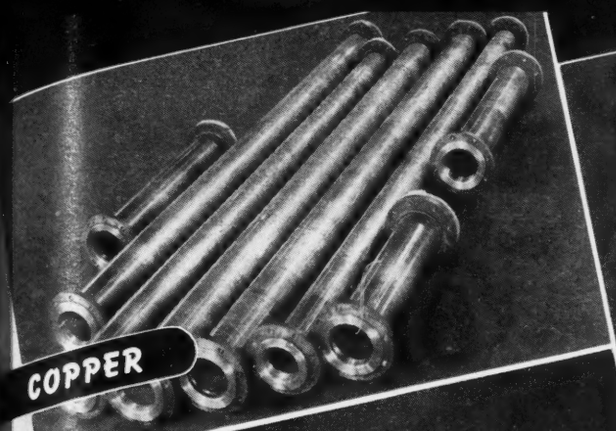
Babbitt Adjustable SPROCKET RIM with Chain Guide

MAKE YOUR OVERHEAD VALVES SAFE and EASY TO REACH—
CONTROL VALVES FROM THE FLOOR

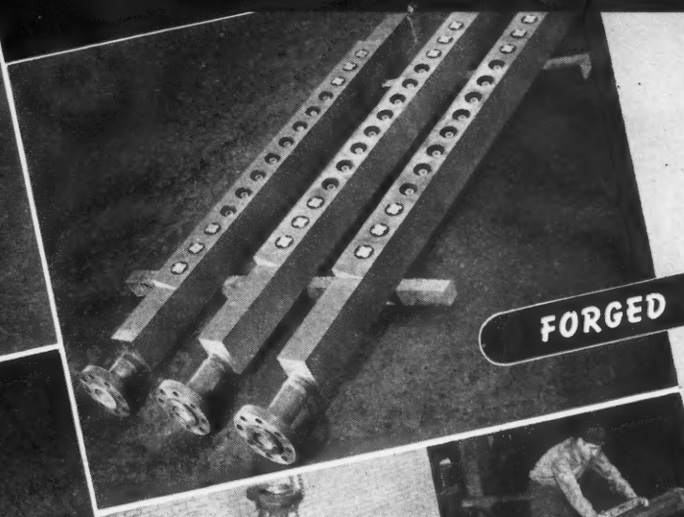
With Babbitt Sprocket Rims on your overhead valves you can control valves instantly from the floor. Far quicker and safer than climbing ladders.

Babbitt Rims are easily attached in a few minutes, are inexpensive and assure safe, positive and instantaneous overhead valve operation. Available for valves of every make or style. Write for details.

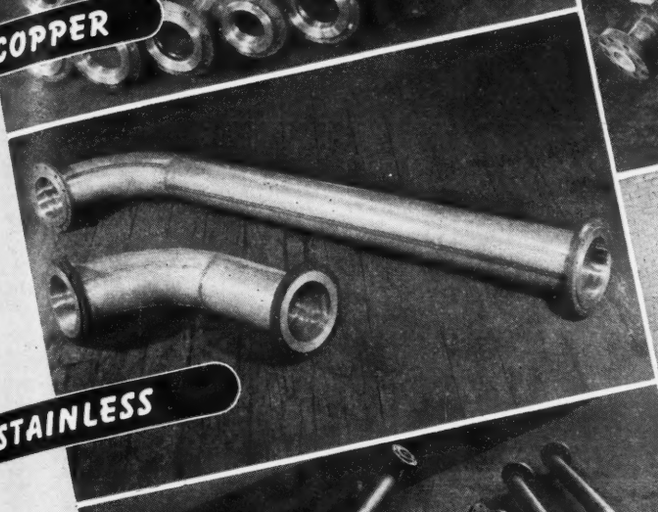
BABBITT STEAM SPECIALTY CO.
New Bedford Mass.



COPPER



FORGED STEEL

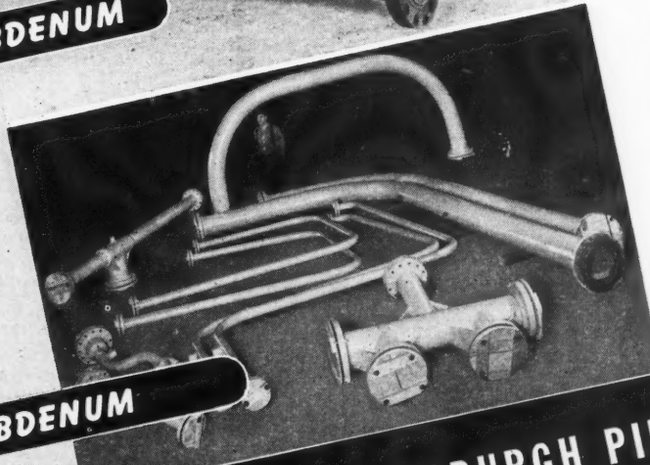


STAINLESS

CARBON STEEL

WROUGHT IRON

CARBON MOLYBDENUM



CHROME MOLYBDENUM

Select the material best suited for your piping requirements—

Pittsburgh Piping can fabricate it!

DIFFERENT metals require varying techniques for the correct fabrication of piping. Pittsburgh Piping not only can make definite recommendations as to the most efficient type of material to use for your own requirements, but can fabricate every type of piping to meet your specifications. This service is based on nearly forty years of experience in designing and fabricating all kinds of piping for central stations, industrial and chemical plants, paper mills, and other process industries. Your nearest Pittsburgh Piping representative, listed below, will be glad to give you more complete information.

PITTSBURGH PIPING & EQUIPMENT CO.
10 FORTY-THIRD STREET PITTSBURGH, PA.

Woolworth Bldg., New York
Public Sq. Bldg., Cleveland
Occidental Bldg., Indianapolis
10 High St., Boston
Peoples Gas Bldg., Chicago
Liberty Life Bldg., Charlotte
Union Guardian Bldg., Detroit
525 Market St., San Francisco

BALDWIN-HILL
B-H
INSULATIONS

No. 1 INSULATING CEMENT

Effective up to 1800° F.

No. 1 in LOW HEAT LOSS
Its Rockwool base contains millions of dead-air cells which retain all their physical properties, contributing to low thermal conductivity.

No. 1 in COVERAGE
As much as 60 sq.ft., 1" thick per 100 lbs. when wet. Dry coverage is approximately 55 sq.ft.

No. 1 in LOW SHRINKAGE
Carefully selected binding agent combined with tightly rolled nodules of water repellent Rockwool cut shrinkage to the minimum.

No. 1 in ADHESIVENESS
Adheres immediately to brick or metal surface and forms a bond which strengthens upon drying.

No. 1 in ECONOMY
100% reclaimable up to 1200° F. No breakage or loss in storage. Saves time and labor in applying.

Send for Catalog giving complete data on entire line of Heat Insulation Products

BALDWIN-HILL CO.
575 KLAGG AVE. TRENTON, N. J.

COTTRELL PROCESS OF ELECTRICAL PRECIPITATION

universally recognized as a standard method of removing

DUST, FLY ASH, FUME, MIST & FOG *from* GASES

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28 years of research development and operating experience by the affiliated Cottrell Companies throughout the world is incorporated in the

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offered to meet the requirements of any problem by

RESEARCH CORPORATION

405 LEXINGTON AVENUE
NEW YORK CITY

59 EAST VAN BUREN STREET
CHICAGO, ILL.

W H Feldman, vice-president in charge of sales since 1937, has recently been elected general manager of Electric Machinery Mfg Co, Minneapolis, Minn. He has been associated with the company for 18 years, having been in charge of district sales in Cleveland and Chicago before his appointment as general sales manager in 1937. He was elected a director in 1936.

T F Barton, for the past two years assistant district manager of the New York district of General Electric Co, has been appointed district manager. He entered the employ of the company in 1906 and held various positions in the organization. In his new position Mr Barton becomes administrative head of apparatus sales organization for states of New York, Connecticut and northern New Jersey.

Herbert L Battles, for many years chief power plant engineer of Fitchburg (Mass.) Gas & Electric Light Co, was guest of honor at a 75th birthday dinner recently, commemorating his 58 years of service with company. He was presented with gifts from the company and fellow employees.

BUSINESS ITEMS

General Electric Co, Schenectady, N. Y. announces several appointments and other changes in personnel. Frederick H Babcock, who entered the employ of the company in 1911, and since 1927 has been assistant to vice-president C W Appleton, has been appointed manager of the Central Station Dept of the New York district. Charles W Appleton, vice-president mentioned above, in charge of general relations with public utilities, has retired because of ill health. He had been associated with the company for 21 years. Dr W D Coolidge, a director of the G E Research Laboratory, has been made a vice-president, as has Stuart M Crocker, formerly manager of the company's Air Conditioning Division. Dr Coolidge will continue as head of the laboratory, while Mr Crocker will make his headquarters

MEETINGS

American Institute of Electrical Engineers —*Winter Convention, January 27–31, 1941, Bellevue-Stratford Hotel, Philadelphia, Pa. H H Henline, secretary, 29 W 39 St, New York, N. Y.*

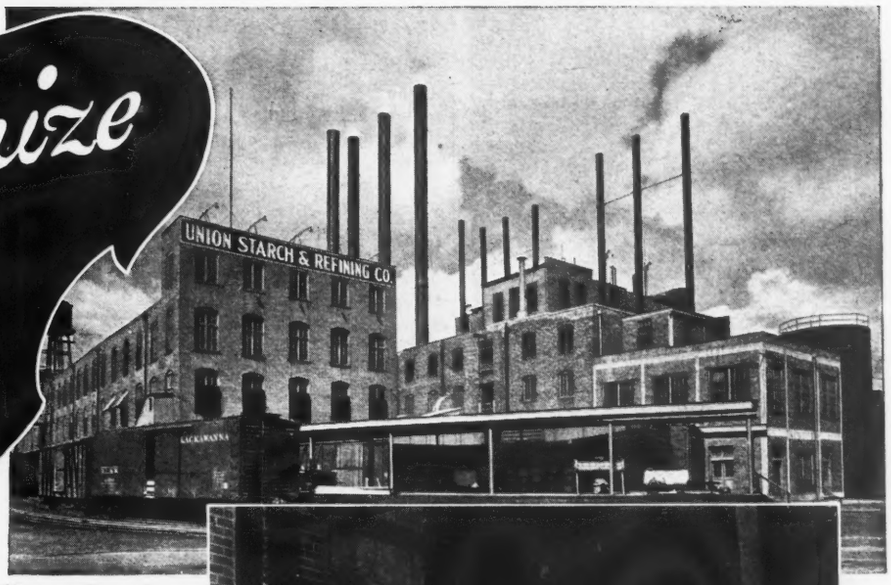
American Society of Heating and Ventilating Engineers—*47th Annual Meeting, January 27–29, 1941, Hotel Muehlebach, Kansas City, Mo. A V Hutchinson, secretary, 51 Madison Ave, New York, N. Y.*

American Society of Mechanical Engineers —*Spring Meeting, April 1–3, 1941, Atlanta, Ga. C E Davies, secretary, 29 W 39 St, New York, N. Y.*

Louisiana Engineering Society — *Annual Meeting, January 10 and 11, 1941, St Charles Hotel, New Orleans, La. A M Hill, secretary, 422 St Charles Hotel, New Orleans, La.*

National District Heating Association— *Annual Meeting, June 10 to 13, 1941, William Penn Hotel, Pittsburgh, Pa. John F Colline, Jr, secretary-treasurer, 1231 Grant Bldg, Pittsburgh, Pa.*

Modernize with HAYS



FOR the past 8 or 9 years The Union Starch and Refining Company of Granite City, Illinois, has had a constant problem on its hands to keep its steam generating equipment in pace with its increasing steam demand.

For 30 years steam requirements had been met by six 400 h.p. longitudinal drum boilers fired by natural draft chain grate stokers.

In 1932, in an attempt to meet the ever-increasing load, a changeover to natural gas was made to avoid installing additional boilers. By 1936 the load had increased to peaks of 160,000 lbs. per hour making it absolutely necessary to completely modernize the steam generating equipment.

The first step was the installation of a four-drum Stirling type steam generator at 60,000 lbs. per hr. continuous steaming capacity with 75,000 lbs. per hr. peaks guaranteed for four hour periods. This unit has a nominal rating of 800 h.p. As fast as possible two additional units identical with the first were installed and all were placed under automatic operation through the medium of a Hays Combustion Control System. The control panel for one of the units is shown above.

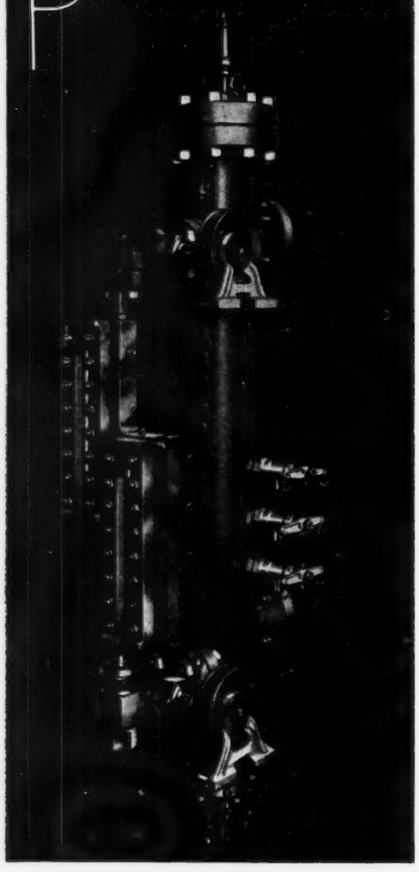
The Hays system of automatic combustion control holds the steam pressure right on the line in spite of the widely fluctuating load, steaming at times as much as 25,000 lbs. per hr. in excess of its guaranteed 75,000 lbs. per hr. capacity. At the same time a virtually constant CO_2 in excess of 12½% is maintained as well as a constant furnace draft. The fact that all three of these new units are Hays equipment is mute evidence of satisfaction.

Hays engineers will be glad to advise how instruments and control may be applied to your steam generating problems. Write us—no obligation.

ENGINEERS PLEASE NOTE:
Tear off the bottom of this ad and mail with your name and address to The Hays Corporation for copy of "Automatic Combustion Control and its Relation to Lower Steam Costs."

The HAYS CORPORATION
SINCE 1901
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

POSITIVE
Protection



Yarway's unique Hi-Lo Alarm mechanism utilizes balanced *solid weights* that are as indestructible and unchanging as the metal itself. Operating on the displacement principle, they literally "weigh the water level."

When the high or low water emergency occurs—instant, positive, powerful, hair-trigger *action* results—giving warning of danger by whistle, light, or both.

Yarway Water Columns, eight standard models, iron bodies with screwed connections for pressures up to 250 lbs., forged steel bodies with flanged connections for pressures up to 1500 lbs., are fully described in Catalog WG-180. Write for a copy and working model.

YARNALL-WARING COMPANY
100 Mermaid Ave. Philadelphia

YARWAY
FLOATLESS HI-LO ALARM
WATER COLUMN

in New York and cooperate and be assisted by commercial departments there.

MONSANTO CHEMICAL CO, St. Louis, Mo., announces that Frederick C Renner, assistant manager of the New York branch of the company, has been promoted to the position of assistant manager of sales of the company's Organic Chemicals Div, with headquarters in St. Louis. Clare F Trombley will replace Mr Renner in the New York office. Mr Trombley was formerly in charge of sales of Organic Chemicals and Phosphate Div products at the Everett, Mass., office of the company.

JOHN A ROEBLING'S SONS CO, Trenton, N. J., announce appointment of Horace E Thorn as manager of Philadelphia branch office. He will have charge of sales of company's complete line.

BLACKMER PUMP CO, Grand Rapids, Mich., has reorganized its sales divisional set-up. In the expansion, Bruce P Hetler, formerly general sales manager, is now manager in charge of engineering sales, and J B Trotman now becomes general sales manager in charge of sales distribution and advertising. Mr Trotman is a newcomer to the Blackmer organization, but has had experience in pump sales with Goulds Pumps, Inc, and more recently with Roots-Connersville Blower Corp, Turbine Pump Div.

AMERICAN ENGINEERING CO, Philadelphia, Pa., announces appointment of C E Harrison and E W Sharninghausen as general manager and treasurer, respectively. Mr Harrison will have general supervision of entire activities of company in addition

C E Harrison

to his duties as vice-president. Mr Sharninghausen was with the Otis Elevator Co for a number of years, resigning as assistant general purchasing agent. He became purchasing agent of the American Engineering Co in 1918, and will continue to serve as such in addition to his duties as treasurer.

CARNEGIE-ILLINOIS STEEL CORP announced appointment of E A Brown, Jr, as superintendent of Power and Fuel Div at Gary Works, and L F Collins as assistant superintendent of this division.

HAKO ENGINEERING CO has moved to 315 Thompson Bldg, Tulsa, Okla., and now

SELECTIVE SERVICE
If you want boilers free from scale and corrosion
SELECT SAND-BANUM
and get
100% SERVICE

"The Entirely Different Boiler and Engine Treatment"

Regardless of water or operating conditions, SAND-BANUM removes and prevents boiler scale and corrosion.

AMERICAN SAND-BANUM CO., Inc.
9 Rockefeller Plaza New York City

CATAWISSA

Sectional Cut of No. 210

UNION SWING CHECK VALVES
HORIZONTAL or VERTICAL

Specially adapted to lines in which no stop is installed close to the valve. The Union connection on both ends enables the line to be broken at the inlet end while the check holds the contents of the line.

Eliminates the necessity of an additional Union and nipple either in the outlet or inlet end of the line.

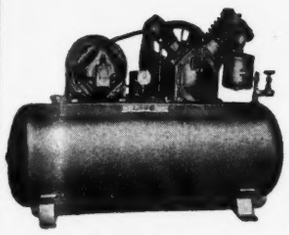
SIZES ¾" TO 4"
Write For Bulletin No. 8B

THE CENTRAL FORGING CO.
CATAWISSA, PENNA.

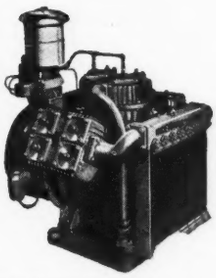
There is a Reason for the

1000 TYPES and SIZES of I-R Compressors

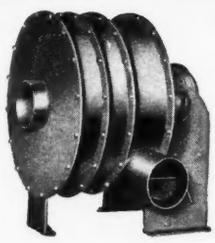
- FOR AIR OR GAS
- FOR ANY PRESSURE
- FOR ANY SERVICE



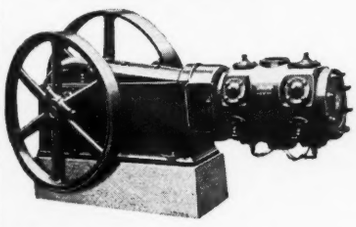
TYPE 30 AIR-COOLED—Pressures to 1000 lbs and vacuums. Sizes ¼ to 15 hp.



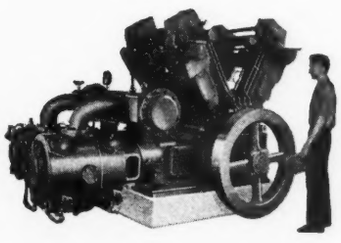
MOTORCOMPRESSOR—Two-stage, air-cooled. Pressures 80 to 125 lbs. 15 to 75 hp sizes.



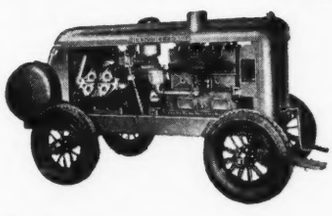
TYPE G MOTORBLOWER—Pressures ½ to 2 lbs. 2 to 30 hp sizes.



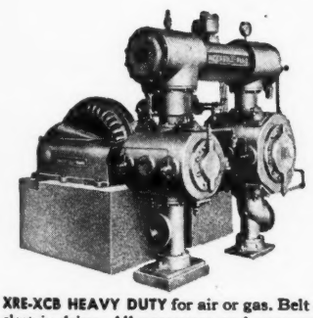
ES HEAVY DUTY for air or gas. All pressures and vacuums. 5 to 125 hp sizes. Any type of drive.



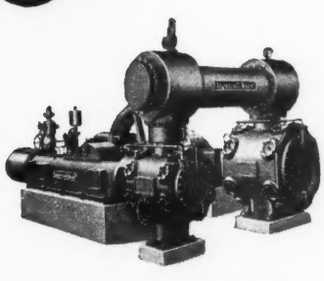
XVO DIESEL-POWERED for air or gas. All pressures and vacuums. 60 to 240 hp sizes.



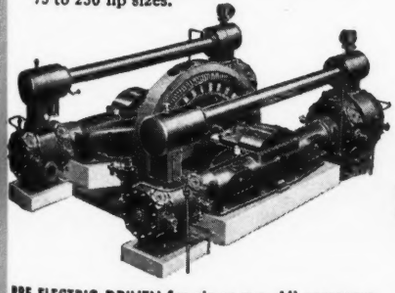
PORTABLES—Two-stage, air-cooled. Gasoline or oil power. All standard mountings. Sizes 55 to 500 cfm.



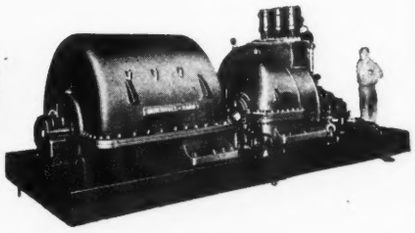
XRE-XCB HEAVY DUTY for air or gas. Belt or electric drive. All pressures and vacuums. 75 to 250 hp sizes.



XPV STEAM DRIVEN for air or gas. All pressures and vacuums. 50 to 1500 hp sizes.



PRE ELECTRIC DRIVEN for air or gas. All pressures and vacuums. Sizes 200 to 3000 hp.



TURBO BLOWERS—Steam driven or electric-motor-drive for large volumes and relatively low pressures. Sizes to 12,000 hp.

EACH TYPE of Ingersoll-Rand compressor illustrated on this page meets the conditions of some particular kind of service better than any other kind. Some types are strictly air compressors; others handle either air or gas.

Some are for permanent stationary installations; some are for semi-stationary installation and can be readily relocated; others are fully portable units for the transit job.

Each type is built in a complete range of sizes. In fact the whole field of compressor needs ranging from vacuums to 15,000 lbs per square inch pressure and sizes from ½ to 12,000 hp is covered by the Ingersoll-Rand line. Units are built for all types of drive.

Your present compressor may be giving no hint of needing replacement. You should, nevertheless, periodically check its performance against a new and modern Ingersoll-Rand compressor. Only in this way will you know when excess operating costs and maintenance expense exceed the investment charges of a new and more efficient machine.

A representative of the nearest Ingersoll-Rand branch office will be glad to help you.

Ingersoll-Rand

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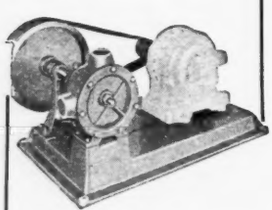
867-14

DO YOU WANT..

to lift a liquid?
to pump "light liquids"?
to pump "heavy liquids"?
to pump against pressures?
to deliver a steady discharge?
to deliver large or small capacity?



THERE IS A VIKING ROTARY PUMP BUILT FOR EACH ONE OF THESE REQUIREMENTS. STATIONARY AND PORTABLE MODELS — SPECIAL DRIVE ARRANGEMENTS, MOUNTINGS AND CAPACITIES. Ask for Special Bulletin 2500-40.

LOOK FOR THIS TRADE MARK — THE SIGN OF A GENUINE VIKING

VIKING PUMP CO.
CEDAR FALLS, IOWA

represents Jas P Marsh Corp, Golden Anderson Valve Specialty Co, and Pittsburgh Equitable Meter Co. Mr O A Steiner, Jr, has joined the organization.

WHITING CORP, Harvey, Ill., announces appointment of Shirley, Olcott & Nichols, as its Washington sales representative to look after government work. Offices are at 202 Mills Bldg, Washington, D. C.

At the 1940 annual meeting of ENGINEERS COUNCIL FOR PROFESSIONAL DEVELOPMENT, held on October 24 in Pittsburgh, Pa., R E Doherty, Carnegie Institute of Technology, was elected chairman and Harry T Woolson, Chrysler Corp, was elected vice-chairman. George T Seabury, secretary, ASCE, was elected ECPD secretary, and H H Henline, secretary, AIEE, became assistant secretary. Other officers elected at the meeting are: A A Potter, past-president ASME, chairman of Committee on Engineering Schools; Charles F Scott, past-president AIEE, chairman of Committee on Professional Recognition; R L Sackett, past-president SPEE, chairman, Committee on Student Selection and Guidance; S D Kirkpatrick, editor, *Chemical & Metallurgical Engineering*, chairman, Committee on Professional Training; and E R Needles, of Ash-Howard-Needles and Tammen, chairman, Ways and Means Committee.

STANDARD HEATER & OIL EQUIPMENT CO, Jersey City, N. J., at a recent meeting appointed Henry S Lewis vice-president. Mr Lewis was formerly research engineer for the Cochrane Corp, and later became assistant to the president of the Davis Engineering Corp.

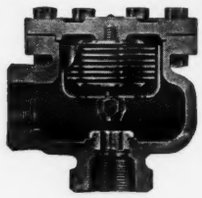
Willam B Scaife & Sons Co announces change of company name to SCAIFE CO. Change in name will not affect corporate structure or management of the company. Founded in 1802 by Jeffery Scaife, the original shop was in what is now downtown Pittsburgh. The name Wm B Scaife & Sons was first used in 1871 and "Company" added in 1901. In 1892 the plant was moved to Oakmont, Pa., where laboratories, general offices and works are now located.

JOHN A ROEBLING'S SONS CO, Trenton, N. J., announce appointment of W K Hanna as manager of the Pittsburgh territory, which includes Western Pennsylvania, and certain areas in Maryland, West Virginia and Kentucky. He has been with the company since shortly after August 15, 1919, when he joined the organization as sales representative.

Labor Will Hold Its Gains, Experts Say

WITH THE RISING ACTIVITY of the national-defense program, labor is in a strong strategic position, and will hold its gains in the months to come, in the opinion of close observers of the underlying situation. Information made available to POWER from a source which cannot be revealed, but considered dependable, is in direct conflict

NICHOLSON



TYPE "C"

NON-FREEZING - HIGH CAPACITY INDUSTRIAL STEAM TRAPS

Cannot freeze (can be placed right out in the weather); is never water-logged; cannot air-bind; intermittent discharge; largest water and air discharging capacity of any trap on the market; same size valve is used on vacuum as at 200 lbs.; moderate in price. "Nicholson" Industrial Trap Bulletin No. 439 on request. Sent on trial.

ALSO:—Nicholson Piston and Weight Operated Traps, Flexible Couplings, Expanding Mandrels, Arbor Presses, Compression Shaft Couplings, Steam Eliminators and Separators, Compressed Air Traps.

W. H. NICHOLSON & COMPANY
125 OREGON STREET
WILKES-BARRE PENNSYLVANIA, U.S.A.

FOR PRESSURES FROM 400 TO 5,000 LBS.—

Positive Protection!

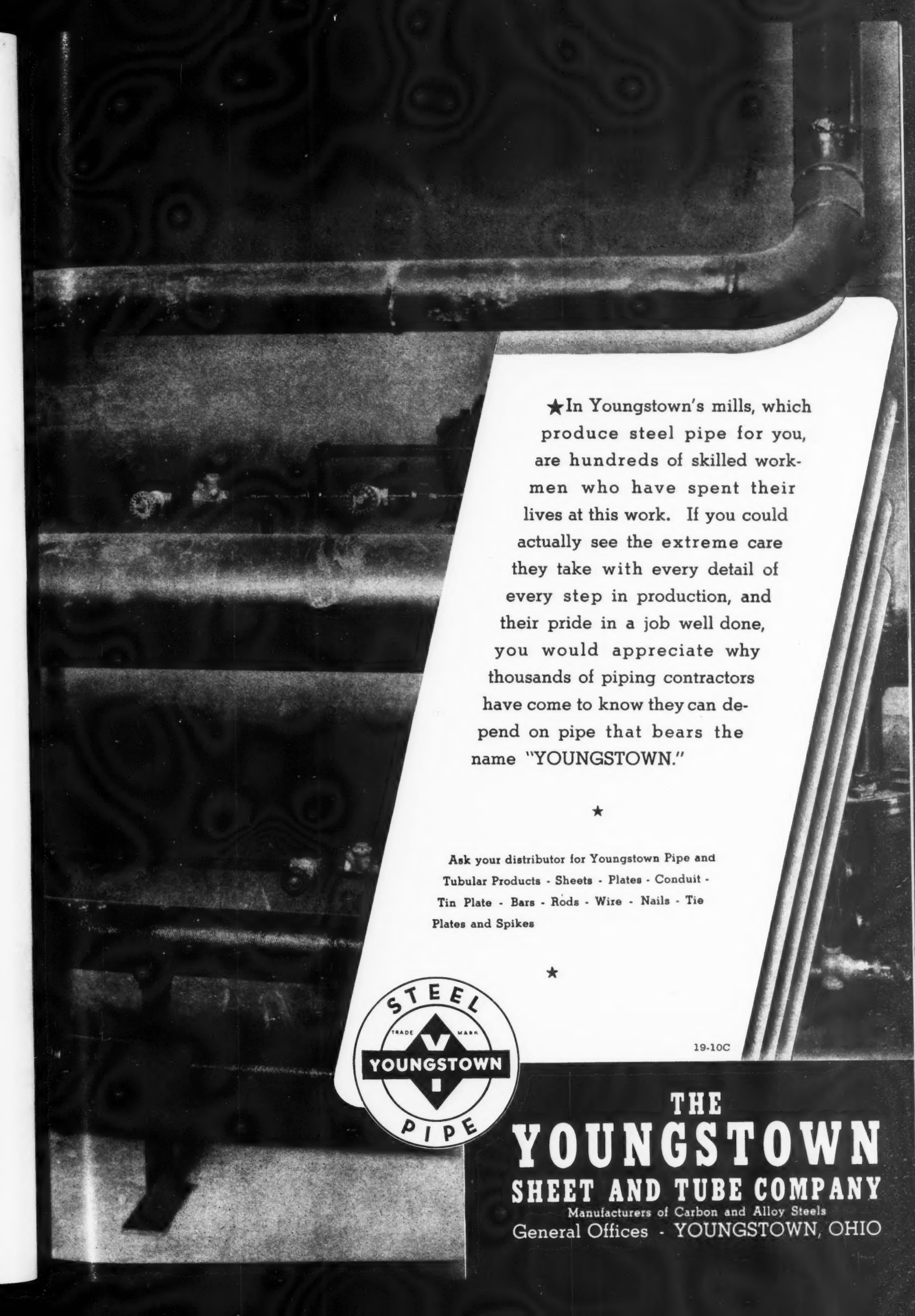
MODEL HRV—HYDRAULIC RELIEF VALVE— Bronze—Made of a very high grade special composition. Outlet connection is in base casting so that, in regrinding, valve seat and outlet piping does not have to be disconnected. Sizes ½", ¾", 1", 1¼", 1½", 2" —for 400 to 800, 801 to 3,000, 3,001 to 5,000 pound pressures. Also made in iron and cast steel.

J. E. LONERGAN COMPANY
Race & Second Sts., Phila., Pa.

Lonergan Valves
GAUGES • SPECIALTIES

★ WRITE for CATALOG— ★

300 Specialties for Power Plants—SINCE 1872



★In Youngstown's mills, which produce steel pipe for you, are hundreds of skilled workmen who have spent their lives at this work. If you could actually see the extreme care they take with every detail of every step in production, and their pride in a job well done, you would appreciate why thousands of piping contractors have come to know they can depend on pipe that bears the name "YOUNGSTOWN."

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Ask your distributor for Youngstown Pipe and Tubular Products - Sheets - Plates - Conduit - Tin Plate - Bars - Rods - Wire - Nails - Tie Plates and Spikes

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STEEL TRADE MARK YOUNGSTOWN PIPE

19-10C

THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon and Alloy Steels

General Offices - YOUNGSTOWN, OHIO

"JAGABI"
HAND
TACHOSCOPE

For Precise Measurements of Speed

THE Tachoscope will win your confidence immediately, because it uses the well-known "speed counter" and stop-watch method, but completely eliminates inaccuracies at starting and stopping. Its precision depends only on the lasting accuracy of a high grade watch mechanism. Giving you the exact number of revolutions in the exact time in which they were made, you *know* you are right! Good for all speeds up to 20,000 r.p.m. and 10,000 feet per minute. A truly accurate and dependable instrument for many kinds of speed measurement.

For showing fluctuations in speed, we recommend our Jagabi Types A and C direct-reading Hand Tachometers.

Write for Bulletin 1505-P, which describes an attractive variety of speed-measuring instruments.

JAMES G. BIDDLE CO.
ELECTRICAL INSTRUMENTS
1211-13 ARCH STREET PHILADELPHIA, PA.

with popular opinion—even business opinion—on several points.

Labor has the whip hand in respect to any differences that may develop. It has the sympathy of the administration and the support of farm interests, and claims, with apparent sincerity, a clean record in its support of the defense program.

Despite the unfavorable publicity given to recent strikes which got out of the hands of the leaders, labor insists that no demands for wage increases have been made, except in a few places where rates were definitely out of line.

Labor resents "slacker" charges, particularly recent public suggestions that it has been responsible for slowing up the defense program.

Prime plank in the labor platform, almost certain to be maintained, is the 40-hour week, according to POWER's information. This does not mean that men will work longer than 40 hours to get out defense contracts (the average in many lines is well over this), but merely that any work beyond 40 hours will be paid for at over-time rates. Labor claims that these over-time rates are not in any sense profiteering—that resulting lower fixed charges per hour balance the higher average hourly labor costs.

Finally, these observers point out, labor is determined to have more voice in any government policies affecting it. It can count on the support of agriculture as long as it does not become radical politically and reciprocates by backing farmers' claims. Any attempt to straightjacket labor will almost certainly meet counter proposals for equivalent restrictions on industry.

Current Comment

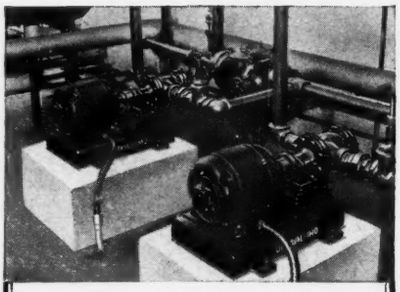
Private Plants in Calif. Are Mainly Motor Driven

IN A FRIENDLY SPIRIT we call your attention to page 57 of the June issue of POWER, introducing the annual Oil and Gas Power section. The statement is made:

"Thus direct engine drive becomes almost standard for cotton ginning, pipeline or water pumping and preferred for refrigeration. . . . Ability to burn a waste product puts gas engines in sewage-treatment plants."

Far from being standard for cotton ginning, direct-engine drives are used on only a very small portion of the San Joaquin Valley cotton gins within the territory Pacific Gas and Electric serves. Of the ninety-seven gins within our system service area, at least 85% are all electric, using purchased power.

The trend in pipeline pumping seems to be toward electric motors using purchased power rather than the contrary. Within the Pacific Gas and Electric territory, which includes the Kettleman and San Joaquin Valley fields, and the major pipelines on the Pacific Coast, there is now only one line using engines at pumping stations—and this was installed 15 years ago. Naturally, there are a number of older stations still operating steam equipment. Re-



Motor driven fuel oil service pumps in a steel and wire plant

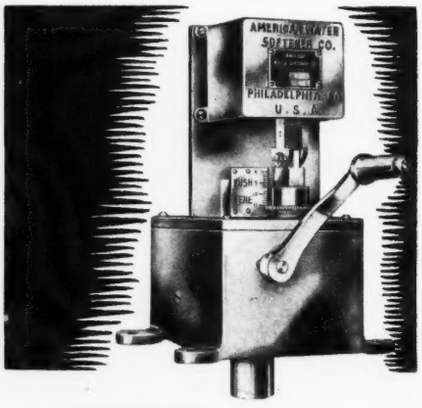
Smooth Flow to OIL BURNERS

The De Laval-IMO delivers oil without shock or pulsation as would a piston moving always in one direction. The uniform delivery and pressure are necessary for good combustion.

In the IMO pump there are no valves or gears and only one stuffing box, which is under suction pressure. IMO pumps can be run at standard motor and turbine speeds and are built in all capacities and for all pressures and to pump any kind of oil, from light Diesel to heavy Bunker C. Ask for Catalog I-66.

IMO
I MOVE OIL

IMO PUMP DIVISION
of the
De Laval Steam Turbine Co.
Trenton, N. J.



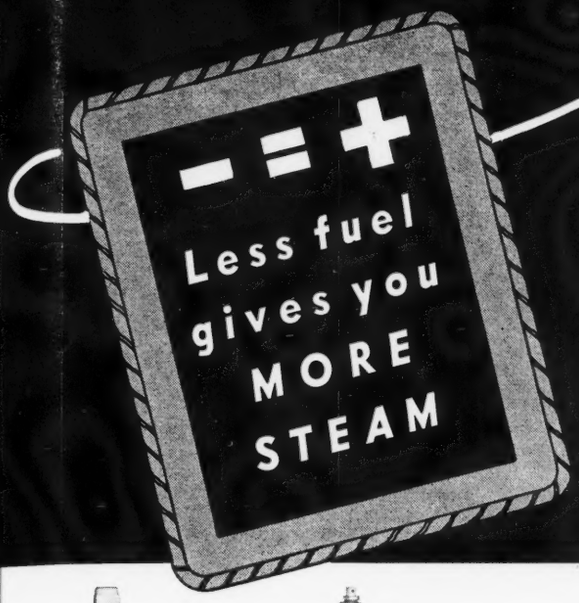
AMERICAN
ELECTRO-MAGNETIC PROPORTIONER

. . . 5 year performance, unconditionally guaranteed . . .

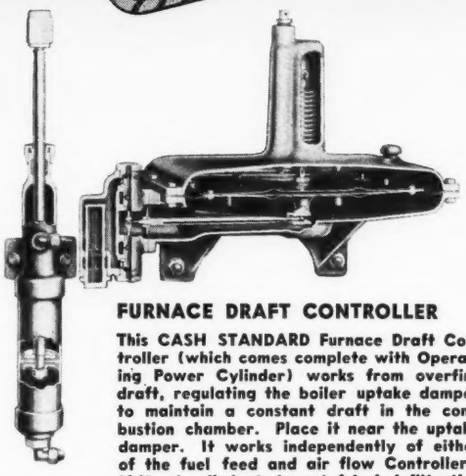
It automatically controls the feed of chemical solution from a vat or tank . . . no orifices to clog . . . precise in operation . . . readily adjusted to varying dosages.

It is the "heart" of the American Hot Process Lime and Soda Water Softening System. This proportioner may be purchased as a separate unit.

The AMERICAN WATER SOFTENER COMPANY
WATER REFINING EQUIPMENT HEADQUARTERS
INDUSTRIAL • PROCESS • RAILROAD • MUNICIPAL
HOUSEHOLD, ETC.
322 LEHIGH AVE., PHILA., PA.

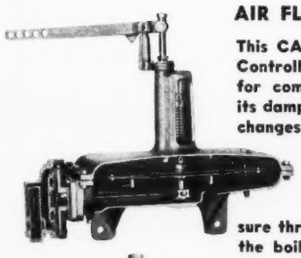


Make this come true by PUTTING *CASH STANDARD* AUTOMATIC COMBUSTION CONTROL TO WORK IN YOUR BOILER ROOM



FURNACE DRAFT CONTROLLER

This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper to maintain a constant draft in the combustion chamber. Place it near the uptake damper. It works independently of either of the fuel feed and air flow Controllers. If it only eliminated wasteful air infiltration it would be a profitable investment.



AIR FLOW CONTROLLER

This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.

FUEL FEED CONTROLLER

This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.

Cutting your fuel bill and yet getting more steam whether you have a stoker, pulverizers, oil burning or gas firing equipment on your boilers, is but part of the benefits you get with CASH STANDARD Automatic Combustion Control — in addition, when you install this modern low-cost control you will greatly reduce your maintenance costs — you will make it possible for your boiler room operators to have much more time for other duties — you will hold your steam pressure within close limits.

CASH STANDARD Automatic Combustion Control is NOT delicate — it WON'T get out of order — and you will find that with this control you maintain the fuel air ratio that is correct for economical combustion.

The CASH STANDARD Furnace Draft Controller works independently (read description at left). Placed properly on your boiler it gives you an immediate start on the money saving benefits of Automatic Combustion Control. You can make this first step for as little as $98. You will find it a good paying investment for, with it, you automatically eliminate air infiltration — decrease the volume of air handled by the furnace — reduce gas velocity through the boiler — allow correct time for heat absorption — increase furnace temperature — insure higher CO_2.

You get Fuel Feed Controller — Air Flow Controller with Operating Power Cylinders (as in the Furnace Draft Regulator), and necessary connecting fittings with many daily cost-saving benefits for as little as $290.

★ There is no difference in the quality or design of these units and those we furnish for the most elaborate jobs and the largest kind of boilers. To make this plan workable, the simple requirement is that the control units be installed conveniently near the apparatus they operate without panel board.

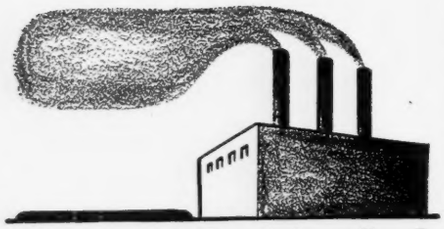
★ Don't hesitate to write for more details — all of the interesting, important facts are contained in Bulletin No. 300 — ask for a copy — no obligation.

OIL CIRCULATOR

The purchase of this oil circulator is optional. All three Controllers shown above can be properly operated by clean water, but it is preferable and cheapest in the long run to operate with this CASH STANDARD Oil Circulator — price $108. equipped with 110-220 v. 60 cy. motor.

A. W. CASH COMPANY
DECATUR, ILLINOIS

CASH STANDARD
CONTROLS . . VALVES



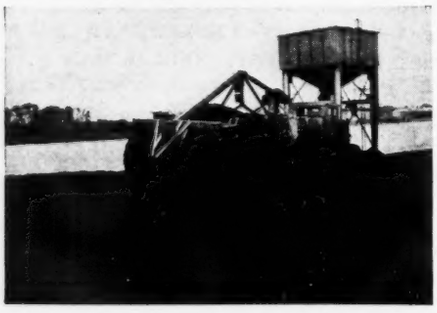
Store and Reclaim Coal EFFICIENTLY & CHEAPLY ..with LeTourneau Scrapers

Three Money-Saving Advantages

1. Eliminates Fire Hazard— **LeTourneau Scrapers store coal in thin, even, horizontal layers with fines thoroly mixed with coarse. Weight of unit traveling over coal closely packs pile, eliminates flues and thus prevents spontaneous combustion.**

2. Saves 50 to 75% on Original Equipment Investment— **LeTourneau Scrapers are comparatively low in first cost, eliminate the need for draglines, overhead structures, stationary drags and most one-purpose conveyors.**

3. Cuts Handling Costs—**LeTourneau Scrapers load directly from rail or dockside . . . haul and spread 25 to 200 tons hourly, depending on scraper size and length of haul. They reclaim the coal, too, have cut out extra operating equipment in the plants of many large users.**



Here a large power plant in Michigan takes coal directly from dockside with its LeTourneau Scraper and "Caterpillar" D8 tractor, stockpiles and seals it in 30-foot high piles. This outfit has handled 388,248 tons of stoker coal since 1937 by this method. Average load 9.88 tons; average hourly output 118.6 tons.

See for yourself how this proven, money-saving LeTourneau method can handle your coal storage problems. Our Field Engineers will gladly work with you. For further details, write TODAY to Dept. 1P.

LETOURNEAU

PEORIA, ILLINOIS • STOCKTON, CALIFORNIA

cently, when General Petroleum required additional pumping capacity on their line running south from Bakersfield, four new electric pumping stations, each with three 200-hp motors, were constructed, with electric service supplied by us.

With regard to water pumping, the Pacific Gas and Electric Co now has about 35,500 agricultural pumping accounts, over 563,000 horsepower. Exact figures on engine pumping for irrigation are not immediately available, but it is known that well over 90% of all water pumping on farms within our system area is by electric power.

Considering the relatively poor load factor and seasonal use of air-conditioning equipment, it is apparent that amortization of engine equipment for this service is well beyond a reasonable period, if at all possible. In commercial refrigeration service, there are three diesel and two natural-gas installations in our entire territory of which only one natural gas installation for an ice skating rink is at all recent, and in this case automobile engines were converted for natural-gas use.

Finally, in the matter of waste-gas usage in sewage-treatment plants—there is only one engine installation in our system—a 75-hp unit supplying a portion of the power requirements at San Leandro. The engineer for the City of Bakersfield seriously considered such an application for their new sewage-treatment plant, but the plan was discarded as not feasible.

Summing up, we believe that the conclusions drawn in the POWER editorial are erroneous—favoring isolated plant operation without adequate justification—as may be seen from the facts above. While we appreciate the fact that isolated plants are necessary in isolated places, electric rates on the Pacific Gas and Electric System are such that purchased power is favored overwhelmingly for cotton ginning, water pumping, refrigeration and sewage treatment plants and for the newer pipe line pumping plants.—H N CARROLL, *Manager, Commercial and Industrial Sales, Pacific Gas & Electric Co.*

Is Warren Noble's Idea Really So New?

IT WAS WITH MUCH INTEREST, and a slight shock, that I read Warren Noble's article "Back to Air Injection?" in the December issue of POWER.

The interest was due to the fact that Mr Noble has obviously been thinking, clearly, about the subject.

The shock was caused by the fact that, also obviously, whoever wrote the subtitle to the article did not know very much about the literature on the subject.

I cannot accept the idea that there is anything unusual or unconventional, or even new, about Mr Noble's scheme.

Reference to a paper (The Automotive Diesel Engine) by Charles E Lucke, delivered before the Metropolitan Section of the SAE so recently as February of 1940 will show that Mr Noble is not alone in recognizing the possibilities of proper injection such as will limit peak pressures.

For many years here at Columbia we have discussed with our students the work of Haselwander, Trinkler, Hoflinger, Ger-

"STANDCO" PILLOW BLOCKS

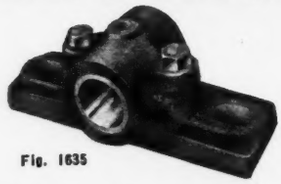


Fig. 1635

Combining clamp block and pillow block requirements in one type, the "Standco" shown above is sturdily built and is offered in a wide range of sizes. Babbitted bearing surfaces are finished beautifully smooth, both faces machined. It can be depended on for long, trouble-free service.

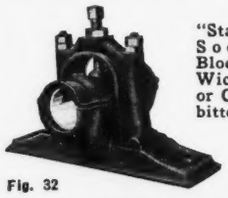


Fig. 32

"Standco" Ball and Socket Pillow Block, Ring or Wick Oiling, Plain or Collar End Babbitted Bearings.

Write for Bulletin

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA

Boston Detroit Indianapolis — Box 577 — Chicago St. Louis San Francisco

HERCULES *Seamless Copper* **FLOATS**

GUARANTEED TO STAND UP!

Every Hercules Float carries our guarantee to stand up under 350 lbs. working pressure and 500 degrees temperature.

Fabricated of seamless copper under our special spinning process. Hercules Floats are uniform in thickness and high in mechanical strength.

You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.

Insure care-free maintenance of water level in your heaters, tanks, reservoirs and other equipment by specifying "HERCULES."

HERCULES FLOAT WORKS
200 Franklin St.
SPRINGFIELD, MASS.

... IT'S AS SMOOTH AS GLASS!

● Unless you have examined a Republic ELECTRUNITE Tube, you've never seen a boiler tube with a surface like this. It's tight and dense — as smooth as glass. It's entirely free from defects and from corrosion-inviting scale and scale pits. We honestly believe that it's the finest boiler tube surface ever produced commercially.

And it is made possible by Steel and Tubes' method of manufacture. As the flat-rolled steel is *cold-formed* into tubular shape, the highly-polished forming rolls burnish the outside surface. Electric welding converts the butted shape into a tube without disturbing the surface by heating. And sizing rolls continue the burnishing action that results in a tube surface of remarkable smoothness.

Uniform grain structure and ductility are assured by normalizing in a controlled reducing atmosphere — without oxidation and WITHOUT THE FORMATION OF SCALE. Hence, no pickling is necessary and no scale pits result.

Before you buy or retube another boiler, let us send a representative with a sample. You can feel the surface for yourself — and learn of the many other features of these better boiler tubes that can save you money. Write Steel and Tubes Division, Republic Steel Corporation, Cleveland, Ohio.

REPUBLIC

REG. U. S. PAT. OFF.

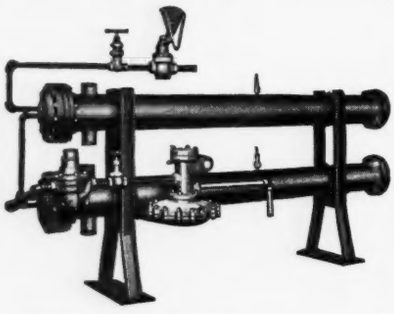
ELECTRUNITE

ELECTRIC RESISTANCE WELDED BOILER, CONDENSER AND HEAT EXCHANGER TUBES

If you must Step Up Your BOILER PLANT OUTPUT

HENSZEY CONTINUOUS BLOWDOWN

Will avoid increased boiler maintenance and expensive shut-downs! Install the modern, continuous, automatic blowdown system in your plant and you will have CLEAN BOILERS, CLEAN WATER and CLEAN STEAM.



CLEAN BOILERS *means:*

• No boiler scale • Less labor cleaning boilers • Lower fuel bill • Greater boiler capacity • Better circulation • Increased life for boilers • No tube burns • Longer period between shut downs.

CLEAN WATER *means:*

No priming • No foaming • No caustic embrittlement • Lower fuel bills • Steady water level • Greater boiler capacity • No clogging of dry pipe • Much less corrosion.

CLEAN STEAM *means:*

Packings last longer • Less cylinder oil consumption • Less wear on rods and cylinders • Less turbine blade erosion • No coating of turbine nozzles and blades • No sticking of reducing valves, non-return valves, traps, etc. • More superheat • Cleaner condenser tubes • Less piston and valve leakage • Less steam consumption • No superheater burnouts.

THE HENSZEY SYSTEM HAS MAXIMUM HEAT RECOVERY OBTAINABLE BECAUSE

High Temperature Heat Exchanger returns heat directly to boiler feed water.

Low Temperature Heat Exchanger transfers the remaining heat to the cold make-up water.

Blowdown is automatically proportioned to make-up.

SEND FOR BULLETIN

HENSZEY COMPANY
Dept. D1 Watertown, Wis.

HENSZEY

nandt, Cummins and others, all of whom were attempting to do the same thing that Mr Noble suggests, so it is quite clear that the idea is not new.

For a reference, I give you a paper, also by Dr Lucke, entitled "The Rising Importance of the Oil-Injection Type of Internal Combustion Engine," and published in the Transactions of the ASME for 1921.

New York, N. Y. F H DUTCHER

Pointers on Safety

AFTER READING two articles entitled "The Old Chief", which dote mainly on safety and unadvisability of hiring men that have been injured on the job, I have a few comments that I would like to make concerning this subject.

In many plants safety is preached, safety posters are placed in conspicuous places, safety committees are elected and yet in these same plants unsafe methods of operating equipment and unsafe working conditions are allowed to continue. This is specially true in departments where only one or two men are employed.

In many cases the equipment is installed in such a way that there is practically no safe way of operating it and still get the results the company is after. That is, men, in order to do their job, must take a certain amount of risk. Also, in this type of plant, one man is usually so overburdened with work that his judgment and alacrity suffer, due to physical and mental fatigue. This is a safety hazard that many plants overlook.

Thus, in accidents resulting from the above cause, the blame can be placed on the company for allowing such conditions to exist. Many times safety hazards are reported but no action is taken to correct them. If the condition is reported more than once the authorities become indignant, with the result that you are labeled a trouble-maker or just plain lazy, because other men work under the same conditions and say nothing. Thus much safety is practised in theory but no material applications are made.

Safety is a combination of men who know their job and good working conditions. No man is a safe worker if he must expose himself to injury while executing his duties. All accidents should be completely investigated and the blame properly placed, as many men have been blackballed when they were not at fault. Therefore, I think that many "horses with scarred knees" are the result of incompetent men being in charge of plant safety or the refusal of the company to spend money to improve working conditions.

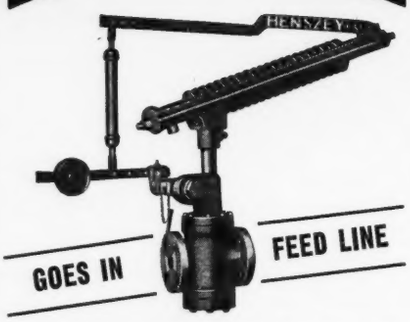
S Vineland, N. J. T DE ROSA

Quicker Way of Figuring Heating Capacity

ON PAGE 116 of November POWER, the following question is asked: "Can a 40-hp boiler operating at rating supply steam to a 1-pipe steam heating system containing 7200 sq ft of radiation? Omit piping and pick-up load."

The answer accompanying the question gives an involved mathematical calculation, with 5-lb steam pressure assumed, etc.

HENSZEY
BOILER FEED REGULATORS

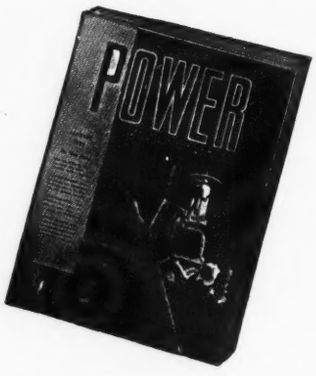


The Henszey Boiler Feed Regulator controls boiler water levels continuously and accurately under *all* load conditions!

These simple, compact, self-contained units go right in the feed line and require no additional structural support. They are as easy to install as a simple gate or globe valve. Once installed and set for operation no further attention is necessary — nothing to get out of order — nothing to reset.

Send for latest Bulletin containing full details.

HENSZEY COMPANY
Dept. D1—Watertown, Wis.

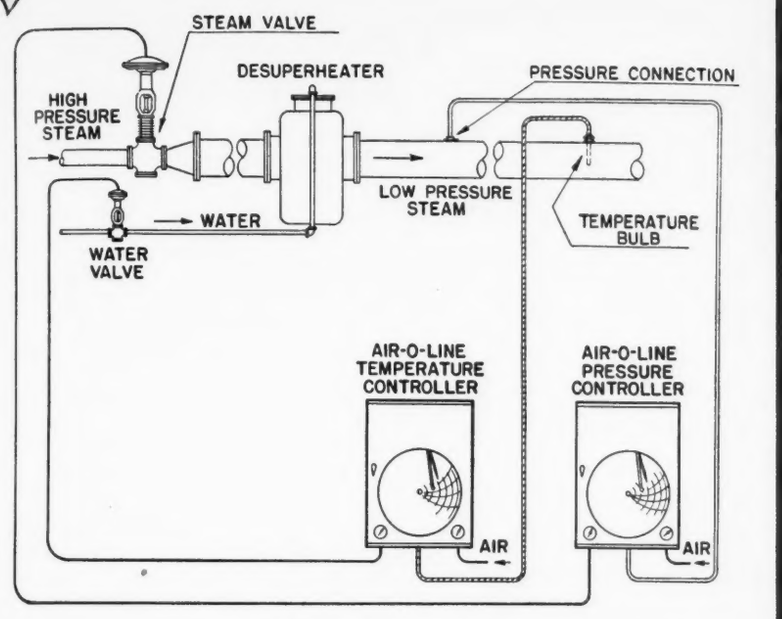


YOUR
Dependable Guide

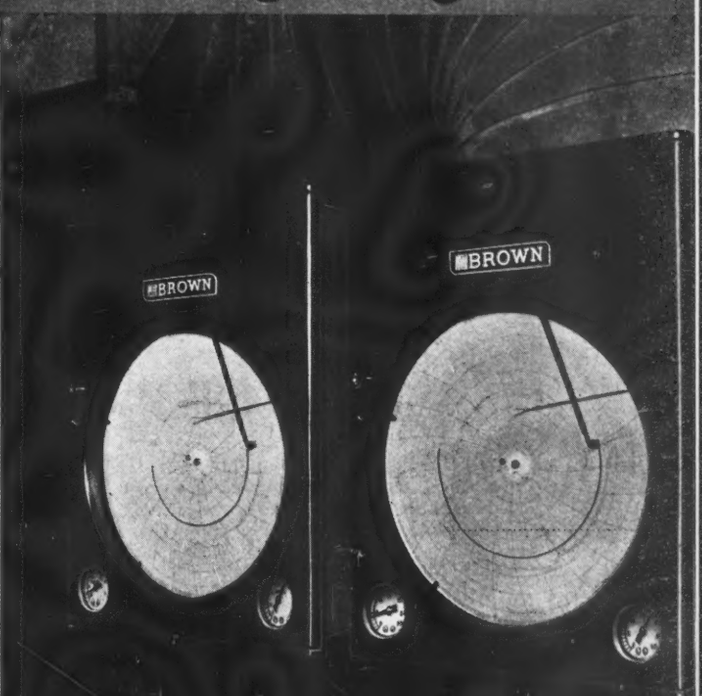
. . . to the big things and little things done each month by operators and manufacturers across the country to raise plant efficiencies, cut costs, and reduce trouble.

It Pays You to
Read POWER Regularly

SOLVES *the* DESUPERHEATER *Control Problem*



BROWN REDUCING VALVE
DESUPERHEATER CONTROL SYSTEM



MAINTAINS DESIRED FINAL STEAM TEMPERATURE AND PRESSURE

The Brown Reducing Valve — Desuperheater Control System shown above, is recommended for modern Central Station and Industrial Power Plant requirements.

In actual operation, the sensitive element of the Pressure Controller is connected downstream and the Pressure Regulating Valve positioning is accomplished by changing air pressure. This is done by a very simple pilot mechanism within the recorder which responds quickly or slowly, depending on flow conditions.

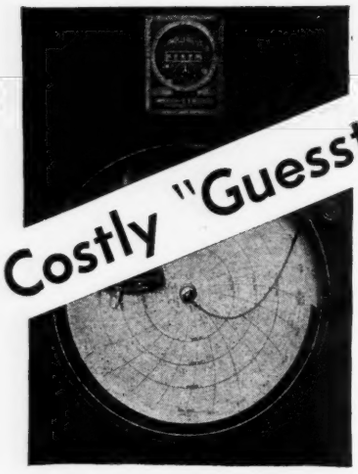
The Temperature Controller is actuated by the sensitive bulb located downstream. The mechanical operation of the instrument from this point is exactly like the Pressure Controller in that by varying air pressure on the diaphragm of an air-actuated water valve, more or less water is made available for mixing with the steam. Again, as in the case of the Pressure Controller, the system is instantly responsive for rapid load changes or can take care of minute drifts.

The control mechanism of both of these instruments is the well-known BROWN AIR-o-LINE unit which recognizes process time lag as well as load fluctuations. In the practical operation of Desuperheater-Pressure Reducing Control Stations for present day requirements, it is essential these be recognized and the instrument be "tuned" in to match the characteristics of the process itself. The success of Brown Pressure and Temperature Controllers is traceable to these built-in features.

The selection of properly sized water and steam valves, etc., depends on local conditions and the entire layout can be discussed in detailed by our local representative. Write THE BROWN INSTRUMENT COMPANY, a *division of Minneapolis-Honeywell Regulator Co.*, 4490 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities. TORONTO, Canada: 117 Peter Street—Amsterdam-C, Holland: Wijdesteeg 4—Wadsworth Road, Perivale, Middlesex—Stockholm, Sweden: Nybrokajen, 7.

BROWN *Air-o-Line* THERMOMETER CONTROLLERS

OUTSTANDING PERFORMANCE WITH SIMPLICITY



STOP Costly "Guesstimates"

Install

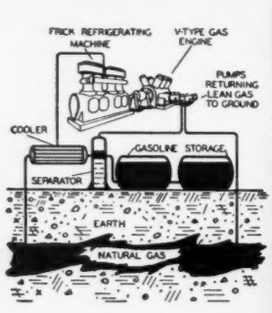
SIMPLEX METERS

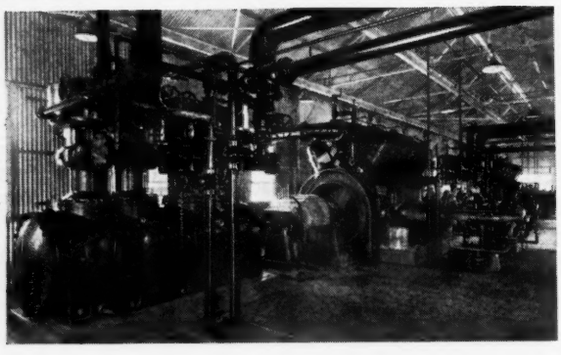
An accurate knowledge of the boiler feedwater consumption, steam flow and other factors relating to boiler performance is essential to economical operation of every steam plant.

Simplex Meters, Type MS, because of their compact form, wider range of applications and lower price, now bring a reliable means of fluid measurement within the reach of all plants.

Let Simplex engineers show you how the proper selection of your metering equipment can insure important plant savings. Write for descriptive bulletin.

SIMPLEX VALVE & METER CO.
6780 UPLAND ST., PHILADELPHIA, PA.





Gasoline now made from natural gas with

They're doing it near Palestine, Texas, using the patented system shown in simplified form in the sketch. Calcium chloride solution sprayed into the gas prevents the freezing of moisture in the cooler.

Daily production of the plant is 38,000 gallons of natural gasoline. Two big Frick compound ammonia compressors, each with four cylinders, cool 40,000,000 cubic feet of gas a day to five degrees above zero.

Another instance of how Frick Refrigeration is indispensable to industry! Whether you need dependable equipment for conditioning air, making ice, doing process work, or any other cooling service, you can rely on Frick Engineers to meet your needs. Let us quote on your requirements.

FRICK CO. Waynesboro, Penna.

TRADE FRICK MARK

Refrigeration

Also, what difference does it make whether the steam goes in a 1-pipe steam job, or a 2-pipe gravity job, assuming that both are properly designed? Or was that put in to make the question harder?

A much simpler way to answer the question is as follows: We know that the standard of heat transfer of cast iron radiation adopted by the Boiler and Radiator Mfgrs Assn and the American Society of Heating & Ventilating Engineers, is 240 Btu per sq ft of radiation, per hour. The rating used years ago, and still used for rapid approximate figures is 250 Btu, which is easy to retain in mind.

We also know that the definition given in the handbooks for a boiler hp, is the evaporation of 34.5 lb of water from and at 212 F, the rule formerly used being the evaporation of 30 lb of water from 70 F. The latter figure is easy to remember and convenient for rapid estimating. We also know that a pound of steam at atmospheric pressure has a heat content of about 1150 Btu; however, you cannot get all of it and 1000 is an easy figure for quick figuring.

Now 1000 ÷ 250 equals 4, so a sq ft of radiation will condense ¼ lb of steam per hour; 7200 sq ft ÷ by 4 equals 1800 lb of steam required. A 40-hp boiler multiplied by 30 lb gives us a capacity of 1200 lb of steam an hour, so the boiler is too small.

Rochester, N. Y. F L WADSWORTH

The Truth About Floats

WE SUGGEST you advise Ed Duff who authored the "Don'ts", page 101, October POWER, to acquaint himself with current practice on one point, at least, relative to water column floats. Good floats don't collapse at 50% overload test; in fact, if the float won't stand such a test it ought to be discarded rather than run the risk of boiler outage for replacement.

We don't imagine Mr Duff intended his statement as derogatory to anyone, but it so happens the company I work for prides itself on supplying the industry with 3 out of every 4 alarm water columns in use today. And they're all actuated by floats! For the past many years we've offered to replace free of charge any float which might fail in the service for which it's intended—including 50% overload test—regardless of the length of time it has been in service. And such replacements are negligible.

Maybe we should reciprocate by cautioning Brother Duff to jack up his auto when storing it for the coming cold months—no use over-burdening the tires, you know!

Cleveland, Ohio G E SAMS

The Important Factors in Buying Fans

IN "SHORT QUESTIONS" page 116, November POWER, we would like to bring to your attention a point that is somewhat contrary to the information we usually preach.

We refer particularly to the question in the middle of the page entitled "What are the five main items to specify when ordering a fan for ventilating service?" and the items are listed in the following order: (1) price,

in 1929 THOMAS A. EDISON wrote—

The first and best source of power is Coal

—and it's even more true in 1941!

The story of power is one of amazing progress . . . but improvement in generating equipment is only part of it. Coal has kept pace! Coal today is not what it was twenty years ago—or even ten. With improved methods of utilizing coal have come better methods of mining it . . . of cleaning and sizing it . . . of maintaining uniformity of performance, of coal delivered *in accordance with industrial engineering specifications.*

Modern coal is a better fuel to do a better job—at lower cost.

Let our engineers show YOU the way to modern savings

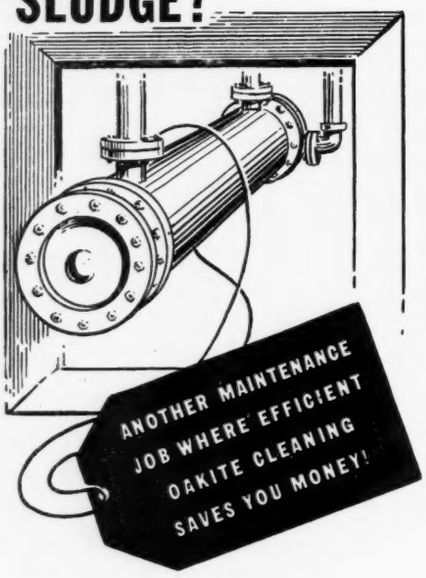
In industrial power plants, large and small, modern coal in modern equipment is producing increased efficiency, lower maintenance charges, more dependable operation—lower fuel costs. Is this true in *your* plant?

Chesapeake and Ohio maintains a staff of Fuel Service Engineers whose job is to help industry get more economical, dependable power for its fuel dollars. Their services are free of charge. If you'd like them to survey your plant, confer with your engineers and make suggestions for cost-cutting, write GEORGE H. REINBRECHT, Coal Traffic Mgr., 2901 Terminal Tower, Cleveland, O.

IT PAY$ TO U$E MODERN . . .

Chesapeake and Ohio Lines

Lube Oil Coolers Clogged with SLUDGE?



Plant superintendents and engineers the country over are finding that sludge-clogged "lube" oil coolers can be easily, quickly cleaned the successful, low-cost Oakite way.

Method is simple. Just circulate solution of recommended Oakite material through system, then rinse. That's all! Sludge and other accumulations are thoroughly, yet safely removed. Heat transfer is restored; lube oil maintained at uniform, proper temperature. And since no dismantling is required, you save time and money . . . units go back in service quickly!

GET THIS BOOKLET!

This 20-page booklet gives more complete data . . . also describes in detail money-saving methods for cleaning and de-scaling Diesel, gas and gasoline engine cooling systems, water-cooled compressors, surface condensers, heat exchangers, etc. It is yours merely for the asking . . . won't you write for FREE copy today?

OAKITE PRODUCTS, INC.
23 Thames Street, New York, N. Y.
Representatives in All Principal Cities of the United States and Canada.

OAKITE *Certified cleaning*
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

(2) capacity, (3) efficiency, (4) rpm, (5) pressure of discharge.

We appreciate the fact that one should not be too critical on the questions and answers as given, but in view of the fact that they are both informative to the older men in the industry, and educational to the younger men coming in, we believe that the proper order is important. Although different people might disagree on the order, we believe that the following order is more nearly correct: (1) capacity, (2) discharge pressure, (3) rpm, (4) efficiency, (5) price.

You will note that in addition to shifting discharge pressure to associate it with capacity, we have particularly moved the question of price from the first and main item to the last item, as we believe that price is not the most important. If price is the first point to be considered, we are of the opinion that a person will select the cheapest fan, or at least, he will have a tendency to do so and by keeping the price the primary item, he is more likely to ignore the life and quality of the fan, which we believe are of great importance.

Therefore, we believe that after comparing the capacities, efficiencies and the rpm's the price should then be considered.

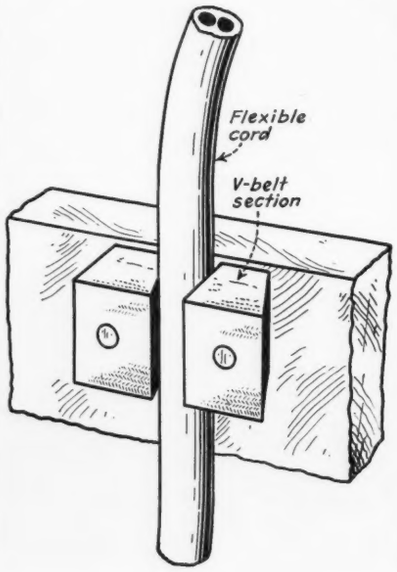
Chicago, Ill. A G SUTCLIFFE

Operating Shorts

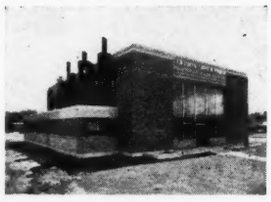
Old V-Belt Makes Lamp-Cord Support

ON A CONSTRUCTION JOB several extension lamp cords came down from an overhead connection. To prevent the strain, caused by workmen pulling on them, being put on the overhead connections, we anchored each cord near the work between two pieces of old automobile-fan V-belt, as in the figure.

About 6 in. of slack was left above the anchors. Then, if a workman pulled the cord too hard it came out of the



MAXIM SILENCERS



FOR CRITICAL INSTALLATIONS

The photograph above shows Maxim MU2 Silencers installed at the light and power plant in La Junta, Colorado.

Here Maxims have to give 24 hour silencing under the most critical conditions, for the plant is within the town itself and 36 feet from the nearest private residence.

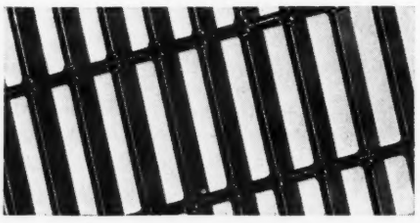
Some installations demand simple muffling . . . some, perfect silencing, as in the case shown above. From Maxim's complete line of silencing equipment you can get the ideal silencer for your particular requirements. Write for details.

THE MAXIM SILENCER CO.
92 Homestead Ave. Hartford, Conn.

BATESGRATES

FILLET WELD

Open Steel Floor Grating



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NO CRACKS, JOINTS, CREVICES

Batesgrates are self-cleaning because of peaked, non-skid cross bar. They have no grooves or rough burned metal to catch grease or dirt. Safe traction. Batesgrates are strictly one piece—no cuts, slots, or punching. Made from Hexagon Shaped Hot Rolled Steel Bars with smoother, larger, much stronger welds. Send today for engineering Catalog No. 937.

When you need grates
SPECIFY BATES
for long-time economy

WALTER BATES CO.
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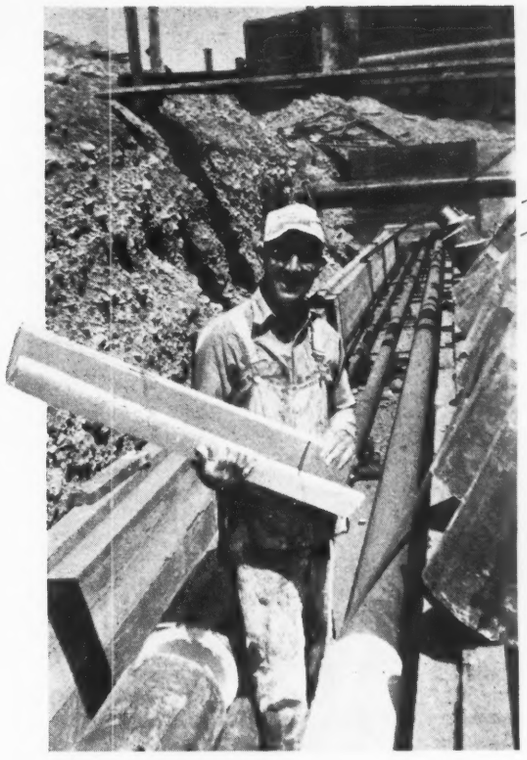
When Steam Distribution Goes Underground



Do the Job RIGHT *with* . . . . CAREY INSULATIONS

THE defense program—new and larger airports — community housing — these and other factors are accelerating demand for underground transportation of steam. The paramount problem is one of efficiency; and this pre-eminently is a matter of correct insulation.

Since the early days of underground steam distribution, CAREY has co-operated with industry to meet this problem more economically. New and vastly superior insulations have been developed that drastically reduce heat losses and greatly widen the practical field of distribution.

Photos show a few of the hundreds of underground systems in which CAREY Insulations have been used. CAREY Products meet *every* service condition from sub-zero to 2500°F. Whatever your problem, put it up to CAREY for permanent satisfaction. Write for Insulation Catalog—address Dept. 16.

THE PHILIP CAREY COMPANY

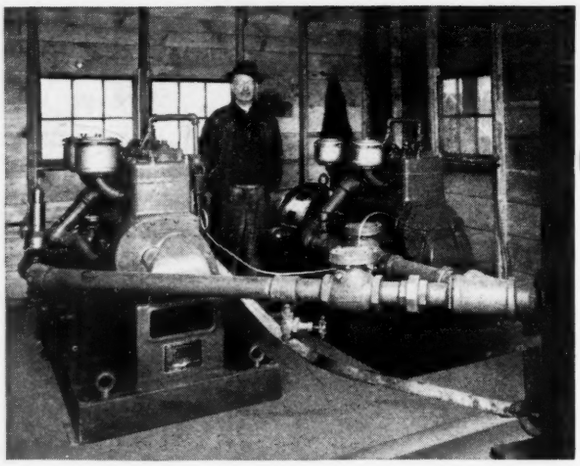
Dependable Products Since 1873

LOCKLAND, CINCINNATI, OHIO

IN CANADA: THE PHILIP CAREY COMPANY, LTD. • Office and Factory, Lennoxville, P. Q.

Carey Magnesia-Asbestos HEAT INSULATIONS

SCHRAMM
AIR COMPRESSORS



COMPACT DESIGN

VIBRATIONLESS NO FOUNDATION

FULL PRESSURE LUBRICATION

AUTOMATIC PRESSURE CONTROL

OTHER SIZES 25 to 600 cfm

SEND FOR BULLETIN 3907

1050 CFM of Air Compressors with Direct Motor Drive.
1—600 CFM with 100 HP Motor.
1—450 CFM with 75 HP Motor.
Total Floor Space About 8½ Ft Square

SCHRAMM, INC., WEST CHESTER, PA.

TOUGH REPAIR
for BROKEN CONCRETE

Avoid accidents! Prevent costly delays! Repair holes, cracks, broken places in concrete floors or resurface an entire area with the durable RUGGED-WEAR RESURFACER. No chopping or chipping required. Merely sweep out spot to be repaired—mix the material—trowel it on. Holds solid and tight right up to irregular edge of old concrete. Cellulose-Processed to provide a firmer, tougher, smoother, more rugged wearing surface. Used indoors or out. Dries fast. Costs only 10c to 14c per sq. ft.

Valuable 74-page "HAND BOOK OF BUILDING MAINTENANCE" available to those requesting on business letterhead.

MAKE THIS TEST!

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Please send me complete RUGGEDWEAR information . . . details of FREE TRIAL OFFER —no obligation.

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Company .....
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City ..... State .....

ADAMANT
FIRE BRICK CEMENT

has a BONDING STRENGTH of 800 lbs. per sq. in.
at room temperature
1270 lbs. per sq. in.
at 2600° F.

That is the report of a leading technical laboratory on the results of impartial tests on the average modulus of 5 test joints of Adamant Fire Brick Cement. It is proof of Adamants' exceptionally high bonding strength which makes the joints stronger than the brick they bond. Adamant is indeed a high quality product . . . made to fill a definite need, not to meet a price. Adamant is ready mixed and easy to apply. Send for complete details.

The P.C.E. of ADAMANT is above 3000° F.

We make a complete line of Refractory Products . . . stocked in all principal industrial centers. Write for literature.

BOTFIELD
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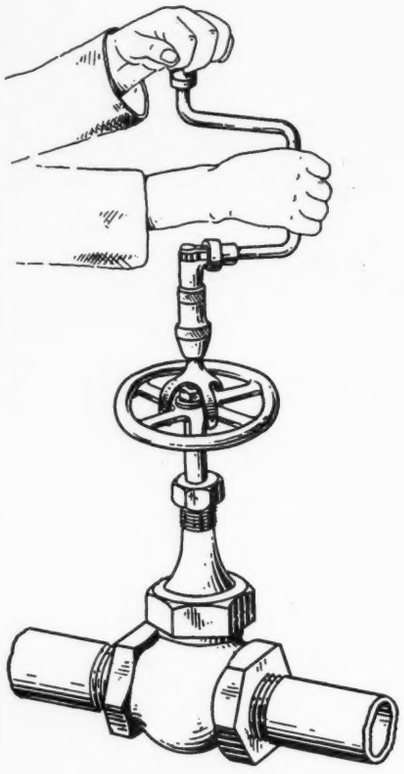
Makers of ADAPRODUCTS, Swanson & Clymer Sts. Philadelphia, Pa.
In Canada, Canadian Botfield Refractories Co., Ltd., 171 Eastern Avenue, Toronto

V-belt clamp and could be replaced in it again without injury to the overhead connection.

Clinton, Iowa FRANK BENTLEY



Tool Speeds Valve Operation

AT ONE PLACE in our plant we have several small valves that have to be opened and closed frequently. To speed up this job I made a tool with three prongs to fit between the spokes of the valve wheels. The shank on this tool was forged square and of a size to fit in a standard wood-bit brace. The figure shows the tool applied to a valve.

Penacook, N. H. CHAS H WILLEY

Simple Way to Hold Insulation in Place

HEAT-INSULATING BLOCKS are difficult to hold in position when assembling them around valves, pipe flanges, etc. I have solved this problem with a long spiral spring under slight tension which is connected around the flange or other parts to be insulated.

With the spring in place, it can be stretched sufficiently to install one block at a time, which is then held there by the spring. When the blocks are all around the flange the spring holds them tightly until they can be tied with light wire; then the spring can be removed.

Aurora, Colo. E J DUFF